

## Systematics and Osteology of Leptoglaninae a New Subfamily of the African Catfish Family Amphiliidae, with Descriptions of Three New Genera and Six New Species

Tyson R. Roberts

*Research Associate, Smithsonian Tropical Research Institute*

Leptoglaninae (type species *Leptoglanis xenognathus* Boulenger, 1902) is proposed as a new subfamily of the African catfish family Amphiliidae. It is characterized by an encapsulated swim bladder with a transverse bony intercapsular bridge between the two lateral capsules as well as by distinctive coloration and behavior. In contrast to other amphiliids, all or most of which are rheophilic or even torrenticolous, typically living in rocky or stony habitats, leptoglanins are arenicolous (sand-dwelling). Several taxa have been observed buried in sand with just the eyes exposed or diving into sand. Four of the five genera and 14 of the 16 known species are endemic to the Congo basin. The Congolese genus *Leptoglanis* comprises a single species, *L. xenognathus*. It differs from all other amphiliids in its highly specialized mouth and jaws and soft digitiform pharyngeal processes and from all other leptoglanins except *Zaireichthys rotundiceps* in having the relatively primitive principal caudal fin ray count of 7+8.

The Congolese species formerly known as *Leptoglanis bouilloni*, although it superficially looks like a short-bodied relative of *L. xenognathus*, does not have an encapsulated swim bladder and is not a leptoglanin or even an amphiliid, but rather a bagrid or claroteid. The species previously known as *Leptoglanis cameruensis*, *L. mandevillei*, and *L. rotundiceps* are placed in the formerly monotypic leptoglanin genus *Zaireichthys* (type species *Z. zonatus* Roberts, 1967). *Zaireichthys* differ from all other leptoglanins and amphiliids in having dorsal and pectoral fins with stout spines and locking mechanisms, thus forming the classical “defensive tripod” of primitive and generalized catfishes. *Zaireichthys* is the only amphiliid with stout serrae on the pectoral fin spine. The leptoglanin *Tetracamphilius pectinatus* also has pectoral fin serrae, but they are much smaller and the pectoral spine does not have a locking mechanism. *Leptoglanis brevis* is placed as a junior synonym of *Z. rotundiceps*. The *Zaireichthys rotundiceps* species complex is characterized by having the pectoral girdle with a large humeral process more or less extensively covered with sharp conical denticulations. These arise indistinguishably from the bony surface of the humeral process and are not true teeth. The only other leptoglanin in which such denticulations have been observed is *Z. zonatus*, which has a few small ones on the humeral process of its pectoral girdle.

*Tetracamphilius* new genus, comprising the species formerly known as *Amphilius angustifrons* and *A. notatus* and two new species *T. pectinatus* and *T. claudestinus*, is distinguished from all other amphiliid genera by tiny fan-shaped jaw teeth with up to four cusps rather than jaw teeth conical or absent. The species of *Tetracamphilius* all have 6+7 principal caudal fin rays. The exceptionally elongate and otherwise distinctive leptoglanin formerly known as *Leptoglanis brieni* is designated type species

of a new genus, *Dolichamphilius*. A new species that might be its closest relative is placed tentatively in *Dolichamphilius*, *D. longiceps*. These two species also have 6+7 principal caudal fin rays. The new genus *Psammophiletria*, comprising two new species, *P. nasuta* and *P. delicata*, differs from all other leptoglanins in having the dorsal fin remote from the cranium and in the extreme reduction of its caudal fin rays, with fewer procurent rays than in any other leptoglanin and only 5+6 principal caudal fin rays, the lowest count known in Amphiliidae.

*Leptoglanis xenognathus* Boulenger, 1902, type species of *Leptoglanis* Boulenger, 1902, is a highly distinctive catfish found only in the Congo basin with specializations not found in other known taxa. *Leptoglanis* has had a long history as a "catch-all" genus. This began with the assignment of *Gephyryoglanis rotundiceps* Hilgendorf, 1905 to *Leptoglanis* by Boulenger (1911). Several more highly distinctive species subsequently were described in *Leptoglanis* by Pellegrin (1926); and by Poll (1959, 1967). Most of these are amphiliids, but "*Leptoglanis*" *bouilloni* Poll (1959) belongs in Bagridae or Claroteidae.

Previous failure to recognize the heterogeneous nature of *Leptoglanis* (*sensu lato*) can be attributed to lack of osteological information. Osteological study was impeded until very recently by scarcity of material, and before that by inadequate methods of preparing small fish specimens for osteological study. This is now somewhat less of a problem, and it has been possible to study cleared and stained osteological preparations of almost all of the leptoglanin taxa. This study treats all taxa that are closely related to *Leptoglanis*. These are recognized herein as forming the subfamily Leptoglaninae of Amphiliidae. Included are *Zaireichthys zonatus*, the species formerly known as *Amphilius angustifrons*, and *Amphilius notatus*, and several previously undescribed species.

The leptoglanin genera *Leptoglanis* and *Zaireichthys* were described originally as Bagridae. A significant advance in their classification came when it was recognized that they are Amphiliidae (Bailey and Stewart 1984:9). These authors based their conclusion on examination of the type species of *Leptoglanis* and *Zaireichthys*. A similar conclusion, utilizing more osteology, was reached by Mo (1991:68–73) but was based on species that are not congeneric with *Leptoglanis* and *Zaireichthys*. For his concept of the genus *Leptoglanis* Mo examined "*Leptoglanis*" (now *Zaireichthys*) *rotundiceps*; for *Zaireichthys* he examined "*Zaireichthys rhodesiensis*," an unpublished taxon that is either a junior synonym or a very close relative of *Z. rotundiceps*. Not surprisingly, his observations indicated that the two taxa are sister species. Nevertheless, Mo looked at leptoglanin osteology in greater detail than previous authors and reported several distinctive characters, notably the posteriorly triradiate palatine bone characteristic of all Amphiliidae.

Many of African Bagridae have numerous large, fleshy fingerlike ("digitiform") processes in the pharynx and especially on the branchial arches; Asian Bagridae generally lack such structures (pers. obser.). I shared this information with Mo, who published it without acknowledgment as part of his evidence for non-monophyly of the Bagridae and for a sister-group relationship of the subfamilies Claroteinae and Auchenoglanidinae of the African family Claroteidae (Mo 1991:62). What I also pointed out to him, but what he failed to report, is that apparently identical structures are found in the amphiliid genus *Leptoglanis*. If these structures (which are generally distributed on the pharynx and not just on the gill arches as indicated by Mo) are homologous and occur only in the taxa in which they have been found thus far, they may be evidence (a synapomorphy) indicating that Amphiliidae are related to (presumably derived from) the African Bagridae or Claroteidae. This would lessen, although it would not eliminate, the possibility that Amphiliidae are most closely related to other Old World (i.e., Asian) catfish groups such as Sisoridae (see He and Meunier 1998; He et al., 1999), Akysidae, and Parakysidae, which share with Amphiliidae the character

complex of a bilaterally compartmented swim bladder enclosed in auditory bulla, or capsules, modified from parapophyses of vertebrae 4 and 5. Whether such a character complex is diagnostic of an ancient monophyletic group of catfishes found in Africa, Asia, and South America or has evolved independently at least three times is one of the major unresolved issues in siluroid higher classification. In Africa it occurs only in the family Amphiliidae (Chardon 1968; Mo 1991; He et al. 1999). Recognition of this character complex in *Leptoglanis* and *Zaireichthys* led to the transfer of these genera from Bagridae to Amphiliidae by Bailey and Stewart (1984:9).

A ventral bony bridge (here named "intercapsular bridge") linking the ossified swim bladder capsules was found in *Leptoglanis xenognathus*, *Zaireichthys zonatus*, *Z. rotundiceps*, and *Amphilius notatus* by Bailey and Stewart (1984:9) (Fig. 1). They did not find a similar bridge in other amphiliids, and predicted that the taxa with the bridge represented a monophyletic assemblage. This monophyletic grouping, as they envisioned it, corresponds to the Leptoglaninae as recognized herein. An intercapsular bridge is present in all of the leptoglanin species for which osteological study material has been available. However, a well-developed intercapsular bridge also is present in the doumein amphiliid *Andersonia leptura* (pers. obser.; He et al. 1999:133, fig. 7), so it is not a character unique to Leptoglaninae. The presence of the intercapsular bridge in *Andersonia* and leptoglanins has led to the hypothesis that Doumeinae is the sister-group of *Leptoglanis* and the leptoglanins (here Leptoglaninae) (*op cit.* 117,142). Their concept of *Leptoglanis* and leptoglanins is based upon study of a single species, *Leptoglanis camerunensis* (here *Zaireichthys camerunensis*).

Most catfish families probably have ribs with a single head and relatively simple articulation. In Leptoglaninae, however, the proximal end of each rib is "bicipital" or two-headed. The ribs articulate with a lateral process or an anteroventral process arising from the corresponding vertebral centrum. In addition, at least in *Leptoglanis xenognathus*, each rib is attached to an anterodorsal process of the corresponding vertebra by a ligament arising just below its bicipital head (Fig. 2).

Amphiliidae are bottom-dwelling catfishes ranging in size from 20 to 150 mm. Eleven genera and about 64 species (including those described herein) are known. The better-known species live in the parts of swift-flowing streams with rocky bottom including mountain streams and rapids of large lowland rivers. These belong to the subfamilies Amphiliinae (comprising the genera *Amphilius* and *Paramphilius*, with some 25 species) and Doumeinae (*Andersonia*, *Belonoglanis*, *Doumea*, *Phractura*, and *Trachyglanis*, with some 23 species). These two subfamilies (especially Amphiliinae) are very widely distributed in tropical Africa. The third subfamily, Leptoglaninae, with 5 genera and at least 16 species, occurs mainly in the Congo basin. Its species live mainly in rivers with extensive stretches of sandy bottom. Amphiliinae and Doumeinae frequently occur together, but are seldom (almost never) found together with Leptoglaninae. Synonymies and information on distribution of Amphiliidae are provided by Skelton and Teugels (1986). For an illustrated key to the genera see Poll and Gosse (1994:186–190).

Due to their small size, near restriction to the Congo basin, and tendency to inhabit large stretches of open sandy habitat with low fish species diversity, Leptoglaninae are among the least known fishes of the African ichthyofauna. When this study began, only two genera (*Leptoglanis* and *Zaireichthys*) and about 10 valid species had been described. The present account adds three new genera and six new species, and more taxa surely remain to be discovered. All of the leptoglanin genera are present in the Congo basin, as are 15 of the total of 16 species recognized here (Fig. 3). Fourteen of the species are known only from the Congo basin and presumably are endemic to it. The only known leptoglanin species not present in the Congo basin is *Zaireichthys camerunensis*, known only from the Niger basin.

Knowledge of the biology of Leptoglaninae is virtually non-existent. Their feeding and reproductive behavior have not been observed. *Zaireichthys rotundiceps* (as *Leptoglanis rotundiceps*) and *Zaireichthys* cf. *dorae* (as *Leptoglanis* cf. *dorae*) were reported as occurring over fine sand, "lying buried with only the eyes protruding" by Skelton (1993:218, 220). The actual sand-diving behavior has not been previously recorded. At Banda (on the Ubangui River upstream from Bangui) I placed several leptoglanins about one inch long in a small bowl with sand on the bottom. When undisturbed the fish rested quietly on top of the sand. If mildly disturbed, they darted about on the sand with incredible rapidity. When badly disturbed, they instantly disappeared below the sand and stayed there for several minutes. While buried in the sand their eyes did not project. Although the species thus observed were not identified in the field at Banda, they were at least two and possibly three species, probably *Zaireichthys mandevillei*, *Tetracauphilus angustifrons* or *T. clandestinus*, and perhaps *Psammophiletria nasuta*. On this and other occasions I noted the extraordinarily copious mucus secretion exuding from the pectoral gland. When handling live specimens at Banda, two of the fish slipped out of my fingers and were suspended by a long transparent strand of mucus 10–12 inches long. The mucus strand was nearly equal in thickness to the body diameter of the fish, and its origin from just above the pectoral fin (i.e., from the axillary pore of the pectoral gland) was observed quite clearly. *Zaireichthys heterurus* was observed diving into the sand, apparently as an escape reaction, in the rivièrè Lulindi. I have observed in several species that the eyes of live species have pupils with slit-like horizontal openings, at least in fish caught in bright daylight. This is perhaps an adaptation related to their sand-diving behavior. Upon preservation the slit-like shape of the pupils fairly rapidly disappears and they appear to be round. From superficial observation of gut contents of cleared and stained specimens, leptoglanins appear to be mainly carnivores, preying on very small arthropods (insects and crustaceans).

This paper takes into consideration literature on *Leptoglanis* and *Zaireichthys* recorded in Eschmeyer's "On Line Fish Species Catalogue" up to 9 September 2002.

## MATERIALS AND METHODS

**MATERIAL EXAMINED.**— Specimens used in this study are deposited in the following institutions: AMNH, American Museum of Natural History, New York; BMNH, The Natural History Museum, London; CAS, California Academy of Sciences, San Francisco; MNHN, Muséum National d'Histoire Naturelle, Paris; MRAC, Musée Royale pour l'Afrique Centrale, Tervuren; and UMMZ, University of Michigan Museum of Zoology.

Specimen lengths given throughout this paper are standard length, SL (from tip of snout to end of hypural plate). Specimens for osteological study were macerated with KOH and stained with alizarin, or macerated with trypsin and stained with alcian blue and alizarin. Radiographs were prepared in dorsal as well as lateral view.

**LOCALITIES.**— Locality data presented in this paper represents nearly all known samples of every species of Leptoglaninae except for the species or species complex *Zaireichthys rotundiceps*. This is the only species with an extensive range outside as well as inside the Congo basin, and it is by far the most frequently collected leptoglanin. It is likely that *Z. rotundiceps* represents several closely related species (pers. obser.; Skelton 1993; Seegers 1996). In presenting the localities, the type locality or localities of the species is given first, generally followed by other localities approximately grouped from N to S and from W to E. The locality dated are presented in the language and wording of the original collector(s). My own original locality records for specimens collected in the Congo basin are a mixture of English and French. Localities of leptoglanin specimens examined from the Congo basin are indicated in Fig. 3 (in some cases two or more localities very close

together for the same species are indicated by a single symbol).

**SYNONYMY.**—Synonymies include primary synonymy (original descriptions and name proposals) and secondary synonymy (name changes). Additional references may be included in a synonymy if they have direct bearing on systematics and identification has been confirmed by examination of voucher specimens or can be determined from the reference itself. In secondary synonymies and misidentifications the name is followed by a comma.

**COUNTS.**—Counts of gill rakers and vertebrae, previously unused by catfish workers, have proved to be extremely useful in distinguishing species in group after group of catfishes: *Akysis* (Roberts 1989a, table 9); *Bagarius* (Roberts 1983); *Chiloglanis* (Roberts 1989b); *Gagata* (Roberts and Ferraris 1998); *Kryptopterus* (Roberts 1989a, table 10); *Leiocassis* (Roberts 1989a, table 5); Pangasiidae (Roberts and Vidhayanon 1991); *Malapterurus* (Roberts, 2000) *Mystus* (Roberts 1989a, tables 7–8; Roberts 1992; Roberts 1994); *Naugra* (Roberts and Ferraris 1998); *Ompok* (Roberts, 1989a, table 11); and *Silurichthys* (Roberts 1989a, table 12).

**GILL RAKERS.**—Counts of gill rakers are extremely useful in distinguishing catfish species. In most catfishes, as is usual in teleosts, the number of gill rakers becomes fixed at a fairly early stage, but in some groups (e.g., *Clarias*, *Mystus*) there are species in which the number of gill rakers increases throughout life. In Leptoglaninae, however, gill raker counts do not seem to be very useful. Due to the small size of the specimens and the small size of the gill rakers, it is difficult or impossible to obtain counts from whole specimens. Counts can be obtained only after the gill arches have been removed from cleared and stained specimens. But the main reason gill raker counts are not useful in Leptoglaninae is because the rakers are few in number as well as very small.

**VERTEBRAE.**—As in other catfishes, vertebral counts are useful for distinguishing species and recognizing evolutionary trends in Leptoglaninae. It is informative to give counts of abdominal and postabdominal (or “caudal”) as well as total vertebrae. Counts given in this paper were all obtained from cleared and stained specimens. They include four anteriormost vertebrae incorporated into the Weberian apparatus. The hypural fan is counted as one vertebra. In amphiliids as in most catfishes the first rib-bearing vertebra is almost invariably vertebra 6. Only one specimen of Leptoglaninae has been noted in which vertebra 5 had ribs (the holotype of *Dolichamphilius longiceps*), and they were much smaller than the ribs on vertebra 6.

In practice, whether counting vertebrae from cleared and stained specimens or from radiographs, the count begins from the first vertebra bearing ribs, i.e. vertebra 6. Abdominal and postabdominal vertebrae are distinguished by the relationship of their hemal spines to the anal fin pterygiophores. Abdominal vertebrae are all those with hemal spines lying anterior to the anal fin pterygiophore that extends furthest anteriorly. If a vertebra has its hemal spine with the tip exactly meeting the anterior tip of the first anal fin pterygiophore, it is included in the count of abdominal vertebrae. In practice the abdominal and postabdominal vertebrae are readily distinguished in amphiliids by this method, whether in cleared and stained specimens or in radiographs. Vertebrae in the caudal peduncle or peduncular vertebrae are those lying posterior to a vertical line through the posteriormost anal fin pterygiophore. The terms used here and in other papers by me, abdominal and postabdominal, are anatomically correct and easily understood. The definitions are such that they apply to all catfish groups and to nearly all groups of teleosts. One major advantage of these simple definitions is that they can be readily used to obtain vertebral counts from radiographs. Another is that they can be used to obtain counts from fossils of most teleosts, including catfishes (Roberts and Jumnonthai 2000). Total vertebral counts of incomplete fossil fish specimens, although often reported, are almost worthless. When part of a fossil is missing, exact counts often can be obtained for either the abdominal or postabdominal vertebrae.

Counts of abdominal and postabdominal vertebrae are particularly useful in distinguishing cat-

fish species. In many instances related catfish species have the same total number of vertebrae composed of quite different numbers of abdominal and postabdominal vertebrae.

**FIN RAYS.**— All of the rayed fins of amphiliids provide valuable meristic data for systematic study except the pelvic fins, which usually have 6 rays on both sides in all species of Amphiliidae (I have observed a few specimens with 7 rays on one side or the other, and one with only 5 rays on one side). In Amphiliidae, and especially Leptoglaninae, the most useful fin ray counts are those of the caudal fin. None of the amphiliids exhibit the most primitive count of principal caudal fin rays known in catfishes, 9+9, reported only in the primitive Neotropical catfish family Diplomystidae. But the family includes species with nearly all of the principal caudal fin ray counts otherwise known in catfishes (see Lundberg and Baskin, 1969), from 8+9 to 5+6. Leptoglaninae have counts ranging from 7+8 to 5+6. In several taxa the upper principal rays are more numerous than the lower; the new species *Zaireichthys heterurus* has 7+5. Although caudal fin ray counts differ considerably within the family Amphiliidae, and also within some leptoglanin genera (cf. *Zaireichthys*), they usually are constant within a species and in several instances within a genus. The leptoglanin genus *Tetracamphilius* has five species, all with 6+7.

In the dorsal and anal fins, as in most teleosts, sometimes the last ray only and sometimes the last two rays articulate with the posteriormost pterygiophore. The latter condition is usually (but incorrectly) described as “last ray divided to base.” Depending upon the author the last ray divided to base may be included or excluded from the total count fin rays. The last ray, when separately notated, is referred to as “½” (also incorrect, because it is in itself a complete ray). Here the convention is followed of indicating the additional last ray, when it is present, by “½”.

Principal caudal fin rays may be defined as all of the branched rays articulating with the upper and lower halves of the hypural fan, plus one upper and one lower unbranched ray. Principal rays of the upper and lower caudal fin lobes are readily distinguished in Amphiliidae, since they articulate with either the upper or the lower half of the hypural fan and there is invariably a distinct gap between them. All of the rays anterior to the uppermost and lowermost principal caudal rays are the procurent caudal fin rays. A caudal fin ray count given as 10–12.6/7.11–13 indicates 6 upper and 7 lower principal rays, and 10–12 upper and 11–13 lower procurent rays.

**SCOPE.**— This work represents a thorough revision of the subfamily Leptoglaninae to the species level with the exception of the species complex *Zaireichthys rotundiceps*. The latter group is found in eastern and southern Africa including Angola and also in the eastern part of the Congo basin (Seegers, 1989; Skelton, 1993; Seegers, 1996; some new locality records for eastern part of Congo basin herein). BMNH and MRAC have many samples that I have examined only superficially, mainly to verify that they have an elongate denticulated humeral process. Several institutions in eastern and southern Africa have samples that I have not examined. The only other leptoglanin with an extra-Congolese distribution is *Zaireichthys camerunensis* in the Niger basin in West Africa. Its distribution is thus widely disjunct from the rest of the known Leptoglaninae. Leptoglanins are unknown from the Ogooué and other West African coastal basins.

My original intention was to publish a more extensively illustrated osteological account of the leptoglanin taxa together with the systematic revision. Due to difficulties in completing observations on some of the taxa and other commitments the osteological work has been curtailed. Enough has been done, however, to provide evidence for monotypy of the Leptoglaninae, reassign “*Leptoglanis*” *bouilloni* to Bagridae or Claroteidae, and contribute to diagnoses of leptoglanin genera and species.

**ORDER OF TAXONOMIC PRESENTATION.**— The taxa are presented in the following order: *Leptoglanis*, type genus and earliest described genus of Leptoglaninae is given first, followed by *Zaireichthys*, the only other previously described leptoglanin genus. After *Zaireichthys* the three

new genera *Dolichamphilius*, *Psamphiletria*, and *Tetracamphilius* are given in alphabetical order. Within each genus the generic type species is treated first, followed by the other species (including new species) in alphabetical order.

**SUBFAMILY NAMES.**— In this as in my other papers, the subfamily termination is given as “-in” (rather than “-ine preferred by some authors), i.e. “leptoglanin,” rather than “leptoglanine”. This might not be classically correct Latin, but since “-id” is now universally used instead of the more classically correct “-ide” for families, it is consistent to use -in for subfamilies.

**ILLUSTRATIONS.**— For ease of use, the figures are grouped together in a separate section following the bibliography.

## SYSTEMATIC ACCOUNT

### LEPTOGLANINAE Roberts, new subfamily

Type species: *Leptoglanis xenognathus* Boulenger, 1911

**DIAGNOSIS.**— Amphiliid catfishes with the left and right osseous swim bladder capsules connected ventrally by a transverse intercapsular bony bridge. Cranium narrow anteriorly. Anterior fontanelle either small or absent; posterior cranial fontanelle absent. Branchiostegal rays 3–8. Gill rakers poorly developed, a maximum of 10 rakers on leading edge of lower element of first gill arch. Upper elements of gill arch without gill rakers (present in Amphiliinae). Outermost pectoral and pelvic fin rays without elaborate lepidotrichia and unculiferous pads (both highly developed in all Amphiliinae and most Doumeinae). Pectoral fin with only one rod- or plate-like ossified radial element (most other amphiliids and other catfishes with two). Adipose fin invariably elongate. Ribs relatively few, from 3 to 6 pairs (ribs also few in Doumeinae, more numerous in Amphiliinae). Caudal fin, variable in form, from deeply forked to truncate. Principal caudal fin rays 7+8, 7+7, 6+7, 7+5, 6+5, or 5+6 (not 8+9). Principal caudal fin ray counts of Leptoglaninae and other Amphiliidae are presented in Table 1.

**COMMENTS.**— Leptoglaninae comprises arenicolous or sand-dwelling amphiliids occurring mainly in the Congo basin. They are all relatively small species. *Leptoglanis xenognathus*, the

TABLE 1. Principal caudal fin ray counts in Leptoglaninae and other amphiliids (data from Lundberg and Baskin 1969; Skelton 1986, 1989, 1993; and pers. obser.)

<b>n/n+1:</b>	
8+9=17	<i>Amphilius bandoni</i> , <i>A. cryptobullatus</i> , <i>A. kivuensis</i> , <i>A. uranoscopus</i> , <i>A. zairensis</i> , <i>Doumea alua</i> , <i>Paramphilius teugelsi</i> , <i>Phractura</i> sp.
7+8=15	<i>Amphilius longirostris</i> , <i>A. opisthophthalmus</i> , <i>Belonoglanis</i> sp, <i>Doumea thysi</i> , <i>Leptoglanis xenognathus</i> , <i>Paramphilius trichomycteroides</i> , <i>Zaireichthys rotundiceps</i>
6+7=13	<i>Amphilius atesuensis</i> , <i>A. brevis</i> , <i>A. lentiginosus</i> , <i>A. maesii</i> , <i>A. pictus</i> , <i>Dolichamphilius brienii</i> , <i>D. longiceps</i> , <i>Paramphilius firestonei</i> , <i>Tetracamphilius angustifrons</i> , <i>T. notatus</i> , <i>T. pectinatus</i> , <i>Zaireichthys zonatus</i>
5+6=11	<i>Psamphiletria delicata</i> , <i>P. nasuta</i>
<b>n/n:</b>	
7+7=14	<i>Andersonia leptura</i> , <i>Zaireichthys camerunensis</i>
<b>n/n?1:</b>	
6+5=11	<i>Zaireichthys mandevillei</i>
<b>n/n?2:</b>	
7+5=12	<i>Zaireichthys heterurus</i>

largest, attains only slightly over 60 mm in standard length. The smallest species, *Psammphyletria nasuta*, *P. delicata*, and *Tetracamphilius clandestinus*, are only 20 mm or a bit longer. The largest *Zaireichthys* are only 40 mm. At least some species dive completely into the sand (behavior observed for several species collected by me in the Ubangui and elsewhere), an activity unknown in other amphiliids. All or many of them have a large humeral or axial pectoral gland producing mucus. Amphiliinae and the "naked" (plateless) doumein genus *Doumea*, on the other hand, are known for their ability to inhabit torrential streams and to cling to rock substrates by means of their paired fins. The armored (plate-bearing) genera of Doumeinae cling to submerged grassy vegetation in swift current. Such clinging is facilitated by thickened epidermal pads on the ventral surface of the paired fins. When the pads are observed with scanning electron microscopy they are found to be composed of thousands of unculi, or unicellular keratinous hooklets (Roberts 1982). In Amphiliinae and in most Doumeinae (*Andersonia* an exception), these pads are supported by greatly enlarged outer pectoral and pelvic fin rays with numerous expanded lepidotrichia. The pads are either absent or very feebly developed in Leptoglaninae, in which the lepidotrichia of the outer pectoral and pelvic fin rays are simple and relatively few. Unculiferous pads were not observed in specimens of *Tetracamphilius pectinatus*, *T. clandestinus* and *Psammphyletria nasuta* examined with SEM.

With the exception of some of the species of *Zaireichthys*, nearly all of the Leptoglaninae have very narrow heads. The crania of all Leptoglaninae (including *Zaireichthys*) are characterized by narrow frontal bones (or frontal bones narrowed at least anteriorly) and no anterior or posterior fontanels. Most Amphiliinae and Doumeinae have anterior and posterior fontanels; *Andersonia* has the anterior fontanel only. Leptoglaninae have milky white, opaque or translucent (but not glasslike or transparent) bodies with delicately banded or spotted color patterns; some species have very little coloration. As is typical of small sand-dwelling catfishes in South America and Asia, the body sometimes has a faint yellowish tinge and the spotting or banding tend to be yellowish, brownish, or even orangish. Amphiliinae and Doumeinae have darkly opaque bodies with variously mottled cryptic color patterns typical of catfishes inhabiting rocky streams. As in many other sand-dwelling catfishes, leptoglanins are capable of modifying the openings of their pupils, reducing them to small horizontal slits in bright light. Similar pupillary modification has not been observed in Amphiliinae or Doumeinae.

Structure of the dorsal and pectoral fins and their supporting elements differ so much among leptoglanin genera that it might easily be supposed they belong in different subfamilies or in different families. *Zaireichthys* was described as a genus of Bagridae (Roberts 1967a) because it has a stout dorsal fin spine with a locking mechanism and a strong, serrated pectoral fin spine. But *Zaireichthys* is very similar osteologically to other genera of leptoglanins and especially to *Tetracamphilius*, one species of which has a weakly serrate pectoral fin spine but no pectoral locking mechanism (*T. pectinatus*).

#### KEY TO GENERA OF THE SUBFAMILY LEPTOGLANINAE

- 1 Dorsal and pectoral fins without locking mechanisms; dorsal fin with single elongate flexible spine; pectoral fin spine flexible, without serrae or with small serrae in one species . . . . . 2
- Dorsal and pectoral fins with locking mechanisms; dorsal fin with two stout spines, anterior one small; pectoral fin spine stout, with large serrae . . . . . *Zaireichthys*
- 2 Jaw teeth conical . . . . . 3
- Jaw teeth multicuspid . . . . . *Tetracamphilius*



- 3 Upper jaw without fleshy lobes; entire premaxillary with teeth; lower jaw with teeth . . . . . 4  
 Upper jaw with fleshy lobes or fimbriae; anterior portion of premaxillary and lower jaw  
 without teeth . . . . . *Leptoglanis*
- 4 Insertion of dorsal fin near head; upper caudal fin lobe with 6 principal rays; snout without  
 rhinal lobe . . . . . *Dolichamphilius*  
 Insertion of dorsal fin nearer mid-body, over vertebra 11–13; upper caudal fin lobe with  
 5 principal rays; snout prolonged by a discrete rhinal lobe . . . . . *Psammophiletria*

### Genus *Leptoglanis* Boulenger 1902

*Leptoglanis* Boulenger, 1902:42 (type species *Leptoglanis xenognathus* Boulenger, 1902, by monotypy).

**DIAGNOSIS.**— *Leptoglanis*, here regarded as a monotypic genus, is in several respects the most highly modified member of the Leptoglaninae. It has the following specialized characters unique within Amphiliidae: (1) anterior margin of mouth with a single large medial fleshy lobe or fimbria and several lateral fleshy lobes or fimbriae of variable size (Fig. 4b); (2) premaxillary with toothless anterior portion, posterior portion with slender conical teeth (Figs. 4–6); (3) lower jaw toothless and exceptionally elongate (Figs. 4–6); (4) coronomeckelian bone exceptionally large and well defined, immovably articulated to Meckel's cartilage and lower jaw, and with a distinct posterior process for ligamentous attachment to basicranium (Fig. 7b); (5) hyomandibular and quadrate joined by a complex joint consisting of a cartilaginous ball partially enclosed by bony sockets formed in the hyomandibular and quadrate (Fig. 7a); (6) an exceptionally short braincase (Figs. 4–6); (7) pharynx and gill arches with numerous soft fleshy fingerlike or digitiform structures; and (8) pectoral and pelvic fin rays excessively branched (Fig. 9a). Principal caudal fin rays 7+8 (the only other Leptoglaninae with 7+8 principal caudal fin rays is *Zaireichthys rotundiceps*). Vertebrae 20–23+17–19=38–41.

**COMMENTS.**— The oral fimbriae and digitiform pharyngeal structures of *Leptoglanis*, possibly homologous to each other, may be adaptations to feeding on organisms living in the sand. Comparable structures have not been found in any other species of Leptoglaninae or Amphiliidae. Structures comparable to the pharyngeal digitiform structures of *Leptoglanis* occur in many species of the African bagrid catfish subfamilies Claroteinae and Auchenoglanidinae. Structures comparable to the oral fimbriae have not been found in any other African catfish. In other amphiliids virtually the entire oral surface of the premaxilla bears teeth. No other amphiliids are known with a toothless lower jaw. The excessive branching of the pectoral and pelvic fin rays results in terminal branches that are exceptionally long and fine (Fig. 9a), and quite unlike those present in other leptoglanins (Figs. 9b–f). Thus, the paired fins of *Leptoglanis* are exceptionally flexible. The membranes connecting the fin rays of the paired fins are very thin. There is no sign of the large unculiferous pads present on the ventral surface of the pectoral and pelvic fin rays in species of *Amphilius*. *Leptoglanis xenognathus*, *Zaireichthys camerunensis*, and *Z. doriae* are the only leptoglanins with abdominal vertebrae notably more numerous than postabdominal vertebrae. *Zaireichthys camerunensis* and *Z. doriae* usually have fewer total vertebrae than *Leptoglanis*, only 34–39. In other leptoglanins except *Dolichamphilius brieni* the ratio of abdominal to caudal vertebrae is more nearly 1:1. In *D. brieni* (formerly placed in *Leptoglanis*) number of total vertebrae is slightly more (43–44) than in *Leptoglanis*, and caudal vertebrae considerably outnumber abdominal vertebrae. Vertebral counts of Leptoglaninae are presented in Table 2.



*Leptoglanis xenognathus* Boulenger, 1902

(Figs. 1–2, 4–9)

*Leptoglanis xenognathus* Boulenger, 1902:42, pl. 14, fig. 1 (type locality “Ubangi à Banzyville [=Mobaye]”).**DIAGNOSIS.**— Same as diagnosis of monotypic genus *Leptoglanis*.**COMMENTS.**— Specimens from Ubangui and from Stanley Pool usually have 4–9 large dermal lobes or fimbriae (together with several very small fimbriae) on anterior margin of the mouth. The only two specimens known from the upper Congo (57.4 and 47.7 mm) have only 3 large lobes. In other features examined, these specimens are similar to *L. xenognathus* from Ubangui and Stanley Pool, but their status should be reconsidered when more material becomes available. It should be noted that these very soft structures are highly susceptible to drying, after which they can be difficult to detect.**COLORATION.**— The freshly collected 35.8-mm specimen from Ubangui at Bawili had the body milk-white (opaque, not translucent) in life. The most noticeable color features were on the fins: two broad oblique bands on the dorsal fin, two broad vertical bands on the caudal fin, and a single broad band in the middle of the pectoral fin, all composed of brownish melanophores lying superficially on the fin rays (not in the interradiial membranes). Anal fin with a few fine melanophores on some rays, otherwise colorless. Adipose and pelvic fins without notable color features, almost devoid of melanophores. Dorsal part of head especially snout, basal portion of barbels, and cheeks with fine, faint melanophores; occiput (over hindbrain) with large, brownish melanophores; distal portion of barbels and ventral surface of head without melanophores. Body with fine, faint melanophores concentrated just above and below lateral line canal and in dorsal portions of myoseptal troughs. Three faint oval spots composed of fine melanophores at beginning, middle and end of adipose fin base. Two faint mid-dorsal oval spots between dorsal and adipose fins. Ventrolateral and ventral surfaces of body almost entirely without melanophores. A thin, sharply demarcated black line in midventral myosepta from vent about half-way to anal fin origin.**GILL RAKERS AND DIGITIFORM PHARYNGEAL STRUCTURES.**— Gill rakers numerous for a leptoglanin, with soft fleshy covering and slender axial core staining faintly blue in alcian-alizarin preparations. The 53.4-mm cleared and stained specimen from Stanley Pool has the following counts of gill rakers on leading/trailing edge of gill arches 1–5: (1) 8/0; (2) 10/0; (3) 0/8; (4) 5/3; and (5) 0. The leading edge of arch 4 lacks rakers with an axial core, but its distal portion bears a close-set series of 4 fleshy digitiform structures (Fig. 8b).

Gill rakers and especially digitiform structures are much more numerous in the 62.2-mm specimen (not cleared and stained) from Stanley Pool. It has the following counts of gill rakers of the leading/trailing edge of gill arches 1–5: (1) 12/4; (2) 12/5; (3) 4/8; (4) 2+8/4; and (5) 1. Digitiform structures, mostly much larger than the gill rakers, are as follows: roof of pharynx near posterior margin of hyoid arch with 7 irregularly scattered or clustered; gill arch 1 with 3 on trailing edge of lower part of arch and a row of 6 on upper part of arch and continuing onto roof of mouth; gill arch 2 with 2 on trailing edge of lower limb and 10 irregularly scattered on upper limb and extending onto roof of mouth; gill arch 3 with 5 on dorsomedian part of lower limb; arch 4 and arch 5 without digitiform structures.

**VERTEBRAL COUNTS** (Table 2).— Specimens from the lower Congo mainstream (Malebo Pool or Stanley Pool) have consistently fewer vertebrae (38–39) than those from the upper Congo at Panga (40) and from the Ubangui River (41). This might indicate that they represent different species. The problem should be investigated when more material becomes available.

## MATERIAL EXAMINED

REPUBLIQUE CENTRAFRICAINE: CAS 92614, 35.8 mm, R. Ubangui near Bawili, 68–69 km upriver from Bangui, 5 March 1988, T.R. Roberts; REPUBLIQUE DU CONGO (KINSHASA): MRAC 118463–118488, 22:29.9–64.8 mm, Stanley Pool [=Malebo Pool at KINSHASA], passe devant la refuge Jipo, 17 Oct. 1957, P. Brien, M. Poll, J. Bouillon; UMMZ 196084, 4:41.4–60.5 mm, Stanley Pool, passe devant la refuge Jipo, 17 Oct. 1957, P. Brien, M. Poll, J. Bouillon; MRAC 118458–118461, 3:29.3–62.2 mm, Stanley Pool, le long de l'île Funa, 7 Oct. 1957, P. Brien, M. Poll, J. Bouillon; MRAC 118453–118456, 2:33.3–36.3 mm, Stanley Pool, 27 Oct. 1957, P. Brien, M. Poll, J. Bouillon; MRAC 29644, 57.4 mm, Panga [=Lualaba?], Bock; MRAC 90–29–P–123, 47.7 mm, Chutes Wagenia near Kisangani, 1989, V. Nyangombe.

SKELETAL STUDY MATERIAL.— MRAC 118463–118489, 2:42.9–47.4 mm and UMMZ 196084, 2:41.4–47.4 mm, Stanley Pool, passe devant le refuge Jipo, 17 Oct. 1957, P. Brien, M. Poll, J. Bouillon (cleared and stained with alizarin); MRAC 118463–118489, 53.4 mm, Stanley Pool, passe devant le refuge Jipo, 17 Oct. 1957, P. Brien, M. Poll, J. Bouillon (cleared and stained with alcian and alizarin).

Genus *Zaireichthys* Roberts, 1967

*Zaireichthys* Roberts, 1967b:124 (type species *Zaireichthys zonatus*, by original designation and monotypy).

**DIAGNOSIS.**— *Zaireichthys* differs from all other Amphiliidae in having “a defensive tripod” consisting of stout dorsal and pectoral fin spines with mechanisms for locking them into erect position. First dorsal fin spine (part of locking mechanism) short, second large, non-serrate; dorsal fin branched rays 6. Pectoral fin spine with 4–10 strong serrae on its inner margin; pectoral fin branched rays 7–8. Humeral process of pectoral girdle variably developed, from very short and smooth (non-denticulate) to elongate and extensively covered with small denticulations (the species *Z. zonatus* exhibits an intermediate condition, with a short humeral process bearing a few small but well-defined denticulations). Caudal fin shape highly variable from deeply forked (as in other leptoglanins) to rounded or truncate. Principal caudal fin ray counts highly variable (albeit nearly invariable within each species): 7+8, 7+7, 7+5, 6+7, or 6+5.

**CRANIUM.**— Compared to that of *Leptoglanis*, the cranium of *Zaireichthys* is generalized. The drawing of the dorsal surface of the cranium of *Z. zonatus* (Fig. 11) is not entirely satisfactory, mainly because the single specimen available for clearing and staining did not stain very well and was damaged. Thus it was not possible to distinguish clearly between the pterotic and supraclathrum in the dorsal view, and no attempt was made to draw the cranium in ventral view. The dorsal view (Fig. 11) indicates the striking difference between the skull of a generalized leptoglanin (*Zaireichthys*) and that of one of the most specialized forms, *Leptoglanis xenognathus* (Fig. 5).

**COMMENTS.**— A small first dorsal fin spine is lacking in all other members of the family Amphiliidae, none of which have a stout elongate dorsal fin spine or can lock the dorsal fin into erect position. The pectoral fin spine is non-serrate in all other amphiliids except *Tetracamphilius pectinatus*, which has small serrations on its pectoral fin spine. No other amphiliids can lock the pectoral fin into erect position.

KEY TO SPECIES OF *ZAIREICHTHYS*

This key should work for all of the species included in *Zaireichthys* except for *Z. flavomaculatus* and *Z. dorae* which are too poorly known to be adequately characterized. Specimens of these two species should key out under *Z. roundiceps*. Some meristic and other characters distinguishing the species of *Zaireichthys* (except *Z. dorae* and *Z. flavimaculatus*) are presented in Table 3.

1. Head not bulbous; eyes visible from the side; adipose fin ending well before caudal fin; body spotted . . . . . 2  
Head bulbous due to greatly enlarged mandibular muscles; eyes visible from above only; adipose fin connected posteriorly to caudal fin; body banded. . . . . *Z. zonatus*
2. Humeral process short, without denticulations; principal caudal fin rays fewer than 7+8 . . . . . 3  
Humeral process long and spinelike, more or less extensively covered with denticulations; principal caudal fin rays 7+8 . . . . . *Z. rotundiceps*
3. Abdominal and postabdominal vertebrae nearly equal in number; 3-5 pairs of ribs; principal caudal fin rays not 7+7 . . . . . 4  
Abdominal vertebrae always more numerous than caudal; 6 pairs of ribs; principal caudal fin rays 7+7 . . . . . *Z. camerunensis*
4. Principal caudal fin rays 7+5; head broad, without dermal ridges . . . . . *Z. heterurus*  
Principal caudal fin rays 6+5; head narrow, usually with dermal ridges . . . . . *Z. mandevillei*

TABLE 3. Comparison of the species of *Zaireichthys* (excepting *Z. dorae* and *Z. flavomaculatus*)

	<i>zonatus</i>	<i>camerunensis</i>	<i>heterurus</i>	<i>mandevillei</i>	<i>rotundiceps</i>
head shape	bulbous	narrow	broad	narrow	rounded or blunt
branchiostegal rays	7	6-7	7	6-7	6-7
pectoral spine serrae	3-4	3-5	6-9	7-8	8
pectoral fin rays	8	7	6-7	7-8	8
humeral denticulations	few	-	-	-	many
dorsal fin rays	5-6	4-6	5-6	6	6
anal fin rays	10	9	8-10	9-11	10
caudal fin shape	rounded	emarginate	forked	forked	truncate
principal caudal fin rays	6/7	7/7	7/5	6/5	7/8
procurrent caudal fin rays	10/11	11-13/10-13	13-17/13-15	13-18/12-14	14/12
ribs	5	6	3-5	3-5	5-6
vertebrae	34	35-38	33-34	34-36	36-38
coloration	banded	spotted	spotted	spotted	spotted
collar	-	-	+	+	-
largest specimen (mm SL)	24.5	33.3	34.6	26.2	37.9

***Zaireichthys zonatus* Roberts, 1967**

(Figs. 9b; 10; 11; 12a)

*Zaireichthys zonatus* Roberts, 1967b:124, figs. 3-4 (type-locality lower rapids of Congo River, just below Stanley Pool, at Kinsuka village, within Leopoldville city limits).

**DIAGNOSIS.**—*Zaireichthys zonatus* is immediately distinguished from all other leptoglanins by greatly expanded oral musculature, giving the head a characteristically bulbous appearance (Fig. 10a), and greatly enlarged jaw teeth (Fig. 12a). In the holotype, which has the oral musculature much better developed than in the paratype, the eyes are only visible when the head is viewed from above (Fig. 10a). In all other *Zaireichthys* the eyes are also visible when viewed from the side. Eyes small, eye diameter 11-12 times in head length. Snout broadly rounded. Body with vertical bands having darkened margins (similar coloration in *Tetracamphilius pectinatus* but not in other amphiliids). Dorsal fin spine and pectoral fin spines very stout and short. Pectoral spine with only 4 serrae. Humeral process short, with a few fine denticulations on ventral margin of its tip. Adipose

fin very long, low, with gently rounded (not triangular) margin, confluent posteriorly with procurrent rays of upper caudal fin lobe (adipose fin entirely separate from caudal fin in all other leptoglanins). Gill rakers on leading/trailing edges of gill arches 1–5: 1) 3/0; 2) 3/0; 3) 0/4; 4) 3/3; and 5) 3/0 (from cleared and stained 18.1-mm paratype). Caudal fin rays 11,6+7,11. Vertebrae 16+18 = 34.

**COMMENTS.**— Placement of the nominal species of *Leptoglanis* with stout dorsal fin spine and serrate pectoral fin spines in *Zaireichthys* was proposed by Mo (1991:12). Reservations have been voiced by Seegers (1996:199) who retained the species in *Leptoglanis*, where they clearly do not belong. Presence of minute serrations on the humeral spine of *Z. zonatus*, a character unknown to Seegers, is an additional reason for following the placement proposed by Mo. The alternative is to designate a new genus for *L. rotundiceps* and related forms with denticulated humeral process. This procedure, however, would leave *L. camerounensis*, *L. heterurus*, and *L. mandevillei* without generic placement. The solution adopted here, retaining the species in *Zaireichthys*, seems best at least until further study has been done.

**DISTRIBUTION.**— *Zaireichthys zonatus* is known only from the two type specimens collected in the mainstream rapids of the River Congo just below Stanley (or Malebo) Pool. Although the habitat was predominantly rocky, the specimens were collected on the edge of a sandy area within a meter or so of each other.

#### MATERIAL EXAMINED

**TYPE MATERIAL.**— REPUBLIQUE DU CONGO (KINSHASA): CAS(SU) 64126, 24.5 mm, lower rapids of Congo River at Kinsuka village, just below Stanley Pool, 21 July 1964, T.R. Roberts (holotype); CAS(SU) 64127, 18.1 mm, collected with the holotype (paratype; cleared and stained with alizarin).

#### ADDITIONAL MATERIAL EXAMINED

None; species known only from the two type specimens.

#### *Zaireichthys camerunensis* (Daget and Stauch, 1963), new comb.

(Figs. 8d, 12b, 13)

*Leptoglanis camerunensis* Daget and Stauch, 1963:94–95, fig. 1 (type locality R. Benoué à Lakdo, Cameroun).

**DIAGNOSIS.**— *Zaireichthys camerunensis* differs from all other *Zaireichthys* and all other leptoglanins in having 7+7 principal caudal fin rays, and from all except *Dolicamphilius longiceps* in having 6 pairs of ribs rather than only 3–5. First pair of ribs on vertebra 6 (first pair on vertebra 5 in *D. longiceps*). Neural and hemal spines tend to be simple and slender rather than complexly laminate (Fig. 13). Branchiostegal rays 6/6 or 7/7. Pectoral fin spine with 3 to 5 serrae. Humeral process of pectoral girdle short, without denticulations. No broad black collar just behind head. Gill rakers on leading/trailing edges of gill arches 1–5 moderately large: (1) 7/0; (2) 7/0; (3) 0/6; (4) 3/3; (5) 0/0 (from cleared and stained specimen). Two proximal gill rakers on the leading edge of the first gill arch lie on the leading edge itself; four medial rakers lie on top of the flattened portion of the arch; and one distal raker lies on or nearly on the trailing edge of the arch. On the other arches gill rakers are more clearly located on leading and trailing edges (Fig. 8d). Procurrent caudal fin rays 11–13/10–13. Vertebrae 18–21+16–18 = 34–39. Largest known specimen 33.3 mm.

**COMMENTS.**— The only other amphiliid observed with 7+7 principal caudal fin rays is the armored doumein *Andersonia leptura* (Table 1).

**DISTRIBUTION.**— *Zaireichthys camerunensis* is the only species of leptoglanin known from

north of the Congo basin. It has been found only in the Niger basin, in the Upper Benue in Cameroun, and in the Upper Niger in Guinea (for map of distribution map see Risch, 1992:418).

#### MATERIAL EXAMINED

NIGER BASIN, CAMEROUN: MNHN 1962–1272, 6:17.0–21.7 mm, R. Benoué à Lakdo, May 1960. Stauch (syntypes); NIGER BASIN, GUINEA: MNHN 1988–1151, 3:20.7–23.8 mm, R. Milo à Boussolé, 10 Dec. 1986, D. Paugy; MNHN 1988–1150, 15:23.4–31.7 mm, and CAS 92615, 9:22.4–31.3 mm (3:24.1, 27.2, and 30.0 mm cleared and stained), R. Dele, tributary of R. Niandan, on road from Firawa to Kissidougou, March 1988, B. Hugueny; MNHN 1988–1152, 6:27.4–31.4 mm, R. Bouyé at Bouye (Niandan watershed, Niger basin), 30 April 1987, B. Hugueny; MNHN 1988–1167, 3:29.4–31.4 mm, R. Niandan at Fermessoudou, B. Hugueny; MNHN 1988–1168, 3:28.3–33.3 mm, R. Niandan at Sougounbaya, March 1988, B. Hugueny.

#### *Zaireichthys dorae* (Poll, 1967), new comb.

*Leptoglanis dorae* Poll, 1967:211, fig. 95 (type locality “rapides de la Luachimo, dans les flaques d’eau résiduelles” [Congo basin], Angola).

COMMENTS.— The 27-mm holotype and only known specimen of *Zaireichthys dorae* probably is immature. Pectoral fin spine with 4 or 5 large serrae. Humeral process moderately long, denticulations poorly developed. Neural and hemal processes relatively slender (not laminate). Vertebrae  $20?+17?=37$ . The species should be redescribed from more material.

Note that “*Leptoglanis* cf. *dorae* (non Poll 1967)” briefly described and figured reported from the “Okavango, Kwando, Chobe, and Zambesi systems) by Skelton (1993:220) is not conspecific with *L. dorae* Poll (1967).

DISTRIBUTION.— Known only from the rio Luachimo, Congo basin, Angola.

#### MATERIAL EXAMINED

TYPE MATERIAL.— MRAC 161646, 27 mm, rapides du rio Luachimo, aval du barrage, [Congo basin], Angola, 10 Feb. 1957, D. Machado (holotype *L. dorae*).

#### ADDITIONAL MATERIAL EXAMINED

None; species known only from holotype.

#### *Zaireichthys flavomaculatus* (Pellegrin, 1926), new comb.

*Leptoglanis flavomaculatus* Pellegrin, 1926:204 (type locality “Kamaiembi” [=Sankuru, Kamaiembi, rivière Lulua, Congo basin]; Pellegrin, 1928:29, fig. 17).

COMMENTS.— The holotype and only known specimen is in poor condition. Humeral process long and denticulate (as in *Z. rotundiceps*). Radiographs show caudal fin with 15,7+8,15 rays; vertebrae  $18?+18=36?$  The species should be redescribed from more material.

A single specimen has been reported as *L. flavomaculatus* from the rio Lufume, a tributary of the rivière Luele (in Angola) by Poll (1967:211, fig. 94). It differs markedly from the holotype of *Z. flavomaculatus* in having a finely spotted coloration overall and a truncate caudal fin, and evidently represents an undescribed species.

DISTRIBUTION.— *Zaireichthys flavomarginatus* is known only from the rivière Lulua in southern Congo (Kasai).

## MATERIAL EXAMINED

**TYPE MATERIAL.**— MRAC 19721, 39.3 mm, Kamaiembi, H. Schouteden (holotype *L. flavo-maculatus*).

## ADDITIONAL MATERIAL EXAMINED

None; species known only from holotype.

***Zaireichthys heterurus* Roberts, new species**

(Fig. 14)

**HOLOTYPE.**— REPUBLIC DU CONGO (KINSHASA): MRAC 87-42-P-1140, 31.4 mm, R. Avokoko, affluent rive droit fleuve Zaïre, km 21 route Kisangani-Wanie Rukula, 29 March 1987, L. De Vos and A. Kimbembé.

**DIAGNOSIS.**— *Zaireichthys heterurus* differs from all other amphiliids in having 7+5 principal caudal fin rays. Humeral process moderately long and stout but not denticulated. Barbels attenuate, maxillary barbel extending posteriorly almost to end of pectoral fin spine. Head broadly rounded. Eyes small. Color pattern spotted, with a broad dark collar (as in *Z. mandevillei*) immediately posterior to head. Caudal peduncle moderately slender; caudal fin deeply forked, upper lobe much shorter and smaller, and falcate, lower lobe rounded; fin rays in lower lobe noticeably thicker than those in upper lobe. Largest known specimen 34.6 mm. With growth, individual fish become increasingly stouter, more perhaps than any other leptoglanin species (compare Fig. 14b of the stout 31.4-mm holotype with Fig. 14c of a cleared and stained and much more slender 23.0-mm specimen). Vertebrae 16-17+17=33-34.

**COMMENTS.**— The two non-type specimens from the Lufira both have 7+5 principal caudal fin rays, but the caudal peduncle seems more slender than in other *Z. heterurus*.

**DISTRIBUTION.**— *Zaireichthys heterurus* is widely distributed in the eastern sector of the Congo basin. It occurs in clear, swift flowing tributaries lying to the east of the Congo River mainstream.

**ETYMOLOGY.**— The name *heterurus* is from the Greek *heteros*, different, and *onra*, tail.

## MATERIAL EXAMINED

**HOLOTYPE.**— REPUBLIC DU CONGO (KINSHASA): MRAC 87-42-P-1140, 31.4 mm, R. Avokoko, affluent rive droit fleuve Zaïre, km 21 route Kisangani-Wanie Rukula, 29 March 1987, L. De Vos and A. Kimbembé.

**PARATYPES.**— REPUBLIC DU CONGO (KINSHASA): MRAC 87-42-P-1140-43, 3:23.2-26.6 mm, MRAC 90-47-P-538-549, 12:23.4-30.1 mm, R. Avokoko, 27 Dec. 1987, L. De Vos; MRAC 88-24-P-1-8, 8:22.4-32.5 mm, R. Avokoko, same collection data as holotype (2:26.0-30.4 mm cleared and stained with alcian and alizarin); CAS 92617, 84:17.6-31.5 mm, R. Lulindi, 21 km by road N of Lusangi (route Kongolo-Kasongo), 28 Aug. 1986, T.R. Roberts (4:22.4-23.2 mm cleared and stained with alcian and alizarin); CAS 92618, 24.7 mm, R. Lukuga just downstream from Niemba, 20-21 Aug. 1986, T.R. Roberts; MRAC 90-47-P-524-537, 6:24.9-29.9 mm, R. Avokoko, km 22 route Kisangani-Wanie Rukula, 17 Dec. 1989, L. De Vos, Kambasu; MRAC 90-47-P-564-580, 8:20.7-27.3 mm, R. Avokoko, 19 Jan. 1990, L. De Vos, Kambasu; MRAC 90-30-P-1198-256, 2:24.4-32.3 mm, Chutes Wagenia, Kisangani, 7 Feb. 1990, L. De Vos.



## ADDITIONAL MATERIAL EXAMINED

REPUBLIC DU CONGO (KINSHASA): MRAC 87-61-P-1-2, 2:24.3-26.3 mm, R. Lufira, Oct. 1947, G. F. de Witte.

*Zaireichthys mandevillei* (Poll, 1957), new comb.

(Figs. 8e, 12c; 15a)

*Leptoglanis mandevillei* Poll, 1959:98, pl. 25 fig. 2 (type locality Stanley Pool [Congo R. near Kinshasa]).

**DIAGNOSIS.**—*Zaireichthys mandevillei* is the most slender-bodied and perhaps the smallest species of *Zaireichthys*. Largest known specimen 26.3 mm. Snout more pointed than in other *Zaireichthys*. Eyes small. Barbels attenuate, maxillary barbel extending posteriorly to middle of pectoral fin spine. Most specimens have entire dorsal surface of head with longitudinally oriented, interrupted ridges (presumably keratinous) not observed in other leptoglanins (small, scattered ridges, presumably keratinous, present in some specimens of *Z. heterurus* and *Z. rotundiceps*). Pectoral fin spine elongate, with 7-9 strong serrae. Humeral process very short, without denticulations. Color spotted, with a prominent dark collar just behind head (as in *Z. heterurus*). Caudal peduncle very slender; caudal fin forked, lower lobe larger and longer than upper lobe; principal caudal fin rays 6+5.

**COMMENTS.**—Ridges similar those of *Z. mandevillei* occur on the dorsal surface of the head of an African mochokid catfish, *Chiloglanis reticulatus* (Roberts 1989:159, 169, fig. 5). *Zaireichthys mandevillei* has perhaps the most reduced gill rakers of any leptoglanin. Gill rakers (very small) on leading/trailing edge of gill arches 1-5: (1) 1/0; (2) 1/0; (3) 1/2; (4) 2/1; and (5) 0 (in 22.3-mm cleared and stained specimen) (Fig. 8e).

**DISTRIBUTION.**—Previously known only from Stanley Pool in the Congo River (type locality), *Z. mandevillei* is now reported from the Ubangui and Lualaba. So far as known, it is confined to sandy reaches of the mainstream of the Congo River and its largest tributaries.

## MATERIAL EXAMINED

**TYPE MATERIAL.**—REPUBLIC DU CONGO (KINSHASA): MRAC 118533-536, 4:19.9-22.8 mm, Stanley Pool, entrée de la passe de Limbili, 19 Sept. 1957, P. Brien, M. Poll, J. Bouillon (paratypes).

## ADDITIONAL MATERIAL EXAMINED

REPUBLIC DU CONGO (KINSHASA): MRAC 1313, 19.8 mm, R. Ubangui at Banzyville, 1901, Royaux (poor condition; originally identified as *Amphilius angustifrons*); MRAC 90-30-P-1192, 26.2 mm, Chutes Wagenia, Kisangani, 23 Jan. 1990, L. De Vos; MRAC 90-30-P-1193-1197, 2:22.6-24.8 mm, Chutes Wagenia, Kisangani, 25 Jan. 1990, L. De Vos; MRAC 90-30-P-1198-256, 23:21.2-26.3 mm, Chutes Wagenia, Kisangani, 7 Feb. 1990, L. De Vos; MRAC 90-47-P-581-632, 21:21.9-24.9 mm, Chutes Wagenia near Kisangani, 3-8 June 1990, L. De Vos; MRAC 90-47-P-633-651, 8:22.1-23.3 mm, Chutes Wagenia, Kisangani, 24 June 1990, L. De Vos.

REPUBLIQUE CENTRAFRICAINE: CAS 92619, 22:16.3-24.2 mm, R. Ubangui at Isle Molenge 82 km upriver from Bangui, 27 Feb. and 7 March 1988, T.R. Roberts; CAS 92620, 19.4 mm, R. Ubangui near Isle Baskiki, 75 km upstream from Bangui, 6 March 1988, T.R. Roberts; CAS 92621, 49:13.6-23.9 mm, Ubangui R. near Banda, 72 km upriver from Bangui, 5 March 1988, T.R. Roberts (7:17.0-23.5 mm cleared and stained with alcian and alizarin); CAS 92622, 11:15.3-21.3 mm, R. Ubangui near Bawili, 68-69 km upstream from Bangui, 5 March 1988, T.R. Roberts.

***Zaireichthys rotundiceps* (Hilgendorf, 1905), new comb.**

(Fig. 15b)

*Gephyroglanis rotundiceps* Hilgendorf, 1905:412 (type locality "Im Bubu bei Irangi" [Rufiji basin, Tanganyika])*Leptoglanis rotundiceps*, Boulenger, 1911:352, fig. 273.*Leptoglanis brevis* Boulenger, 1915:169 (type locality riv. Lumumbashi à Elisabethville).*?Leptoglanis wamiensis* Seegers, 1989:285, fig. 1 (type locality Kisangata-Bach bei Mvumi, 32 kilometer SW Kidete, am Wege nach Kimamba/Kilosa im Wami-Einzug NW Morogoro, Tanzania).*?Leptoglanis* sp Seegers, 1989:284 (see Seegers 1996:196)

**DIAGNOSIS.**— *Zaireichthys rotundiceps* of this account, which probably represents several species, has humeral process of shoulder girdle well developed, elongate, with its ventral margin and sometimes entire surface covered with fine denticulations. Pectoral fin spine stout with strong serrae (7 or more in larger specimens). Dorsal fin spine stout, with a well-developed locking mechanism. Caudal fin shape variable, from slightly forked through, emarginate, truncate, or even slightly rounded, but not deeply forked. Principal caudal fin rays 7/8 (only checked in a few specimens). Head broad, snout rounded or blunt, body relatively stout. Adipose fin elongate, its margin rounded. Coloration highly variable, from abundant dark spots in several rows to light pale spotting pattern (never banded). Marks often present on head and fins as well as body.

Gill rakers moderately well developed, leading/trailing edges of gill arches 1–5 with 1) 6/0; 2) 6/0; 3) 0/5; 4) 5/5; and 5) 5 rakers; rakers on leading edge of gill arch 5 (lower pharyngeal) not stained with alizarin or alcian, but clearly discernible (24.1-mm cleared and stained specimen from Luwoyeye). Coloration of the *Zaireichthys rotundiceps* species complex is highly variable, involving more or less numerous spots of variable size and distribution over most of the body. There is no humeral collar or band of dark pigmentation just behind the hind.

**COMMENTS.**—A large denticulate humeral process was observed in all of the type and non-type specimens listed as material examined of *Z. rotundiceps*. Detailed study of all of this material has not been attempted, but some preliminary comments are in order. I have examined the humeral denticulations in a 24.1-mm specimen of *Z. rotundiceps* from rivière Luwoyeye, CAS 92623. Superficially resembling sharp conical teeth, the denticulations are concentrated along the lower margin of the humeral process. Apparently they are not true teeth. They arise directly from the bony humeral process; there are no tooth sockets; and, although the denticulations are numerous and differ in size, there is no sign of any stages of tooth formation or of tooth replacement. Direct comparison of the BMNH syntypes of *L. rotundiceps* and *L. brevis* reveals that they are closely similar, possibly conspecific. For further discussion of *L. rotundiceps* and *L. brevis* see Seegers (1996).

A large denticulated humeral process also occurs in *Z. dorae* and *Z. flavomaculatus*, two poorly characterized species known only from the holotypes, that clearly are not conspecific with *Z. rotundiceps*. A smaller humeral process bearing relatively few denticulations is present in *Z. zonatus*. Similar denticulations have not been reported in any other members of the family Amphiliidae.

*Leptoglanis wamiensis* Seegers, 1996 undoubtedly is a *Zaireichthys*. It may be tentatively regarded as a junior synonym of *Z. rotundiceps*. Seegers emphasized its small size and unique color pattern as species characters. Size and color are highly variable in the samples of *Zaireichthys* identified here as *Z. rotundiceps*. Problems with such characters as body size and number and size of spots in the color pattern (and their intensity) are 1) they are continuously variable and difficult to describe and record, let alone compare; 2) they are probably influenced by non-genetic factors such as water clarity, food availability, and physiological condition; and 3) they differ in virtually every

population sample. Characters that might prove more useful in distinguishing the different species include shape and width of premaxillary tooth patch, length of lateral line canal; and numbers of branched dorsal and caudal fin rays (D. H. Eccles, in lit., 23 Oct. 1979).

Two species of *Zaireichthys* are reported (as *Leptoglanis rotundiceps* and *L. cf. dorae*) from the Zambesi and other southern African localities by Skelton (1993:218–220). The behavior of lying buried in fine sand with only the eyes protruding is recorded for both species by Skelton. *Zaireichthys cf. rotundiceps* in Lake Malawi lives in shells of the snail *Lanistes* (D. J. Stewart, in litt., 18 June 1979).

#### MATERIAL EXAMINED

**TYPE MATERIAL.**—EASTERN AFRICA: BMNH 1905.7.25. 43–46, 4: 20.7–30.1 mm, and MRAC 76–50–P–1. 26.1 mm, Bubu River near Irangi, Rufiji basin, July 1897, O. Neumann (syntypes *G. rotundiceps*); REPUBLIC DU CONGO (KINSHASA) BMNH 1920.5.26.93, 25.1 mm, R. Lubumbashi, Elizabethville, Congo basin, 9 June 1911, L. Stappers (syntype *L. brevis*).

#### ADDITIONAL MATERIAL EXAMINED

REPUBLIC DU CONGO (KINSHASA): CAS 92623, 3:24.1–33.3 mm, riv. Luwoyeye, a tributary of rivière Lukuga, about 10 km by road S of Nyunzu, 22 Aug. 1986, T.R. Roberts (24.1-mm specimen cleared and stained); MRAC 89–43–P–2242, riv. Kawe II, affl. riv. Lubutu, km 260 route Kisangani-Bukavu, & July 1989, L. De Vos; MRAC 182734, 25.4 mm, vallee riv. Lupweshi, affluent de la riv. Lufira, 8 June 1958, N. Magis; MRAC 183297–340, 44:18.8–34.8 mm, au pont route de la riv. Lubumbashi, camp forestier de la Kipopo, 1 and 8 May 1960, T. van den Audenaerde; MRAC 18341–342, 2:22.4–25.2 mm, étang de la station de la Kipopo, June 1960, D.F. Thys van den Audenaerde; MRAC 183343–44, 2:28.7–31.1 mm, Kiubo, dans les rapides au-dessus des chutes des riv. Lufira et Luwilombo, 8 Aug. 1960, T. van den Audenaerde; MRAC 79–1–P–4382, 30.2 mm, riv. Bowa, affl.droit de la Kalule Nord et 1/ affl. droit du Lualaba, pres de Kiamalwa, 2–3 March 1949, G.F. de Witte; MRAC 83416, 35.3 mm, Elizabethville, Parc Heenen, 7 Jan. 1947, Mission Pisc. Katanga; MRAC 90262–90263, 2:34.4–36.3 mm, riv. Koki, entre Mulenge et Kamulenge, 28 Sept.–1 Oct. 1947, M. Poll; MRAC 90264, 37.4 mm, riv. Kitwe, affluent de la Lukuga à Kokompwa; MRAC 93050, 28.9 mm, riv. Luvubu, 9 Sept. 1952, G. Marlier; MRAC 152631–33, 3:24.0–26.4 mm, riv. Kilobelobe, Katanga, 21 June 1963, M. Lips.

OUTSIDE CONGO BASIN.—BMNH 1987.7.13.77, 25.7 mm, Cubango (Okavango) R. at Nkurunkuru, M. J. Penrith; BMNH 1979.12.6.6–10, 5:22.3–25.9 mm, Kunene R. one mile E of Epupa Falls, Oct. 1971, M. J. Penrith; BMNH 1979.12.6.2–5, 4:20.3–25.4 mm, Kwando R. at Choyi near Kongolo, Caprivi, 3 June 1975; BMNH 1979.12.6.30, 30.0 mm, Impalilay Stream near confluence of Zambesi and Chobe, E Caprivi, 7 Aug. 1975, B. van der Waal; BMNH 1979.12.6.1, 23.2 mm, Kafue R., Zambesi system, 16 Dec. 1963; BMNH 1976.12.6.11–13, 3:18.0–19.5 mm, Mazinzi Bay, Lake Malawi (trawled in shells at 11–13 m), Oct. 1974, D. H. Eccles; BMNH 1979.12.6.17–21, 5:20.3–31.7 mm, western affluent streams of Lake Malawi, Oct. 1978, D. Tweddle and N. J. Willoughby; BMNH 1979.12.6.22–25, 4:27.0–33.1 mm, Sabi R., eastern Rhodesia, 4 Dec. 1960; MRAC 90–46–P–1–6, 3:29.9–37.9 mm, Rwimi R., road between Portal and Kasese, Uganda, 13 June 1990, R. Wildekamp.

***Dolichamphilius* Roberts, new genus**Type species: *Leptoglanis brieni* Poll, 1959

**DIAGNOSIS.**— *Dolichamphilius* was placed in *Leptoglanis*, but differs in numerous respects from the generic type-species *L. xenognathus*: (1) body and especially caudal peduncle extremely elongate; (2) pectoral fin with 9–11 instead of only 8 branched rays; (3) pectoral- and pelvic-fin branched rays with long simple branches medially and extremely foreshortened compound branches distally (this character is shared with *Psammiphyletria*); (4) outermost branched ray of pectoral and pelvic fins more elongate, so these fins have a falcate shape; (5) principal caudal fin rays 6+7 instead of 7+8; (6) upper and lower jaws with teeth (vs. lower jaw toothless); and (7) premaxillary bone of generalized usual shape for amphiliids, with entire ventral surface dentigerous (vs. premaxillary with an extensive non-dentigerous area anteriorly).

**ETYMOLOGY.**—From the Greek *dolichos*, long or elongate; *ammos*, sand; and *philos*, beloved, dear. Gender masculine.

***Dolichamphilius brieni* (Poll, 1959), new comb.**

(Figs. 9e, 16a)

*Leptoglanis brieni* Poll, 1959:96. pl. 24 fig. 2 (type locality “Stanley Pool, passe devant le refuge Jipo”).

**DIAGNOSIS.**— *Dolichamphilius brieni* is readily distinguished from all other leptoglanins by its extremely slender body and elongate caudal peduncle; pectoral fin with a flexible spine and 11 rays; first branched ray of pectoral and pelvic fins distinctly longer than other rays; both jaws with conical teeth; lower jaw with only a single short row of 8–10 fine sharp conical teeth; caudal vertebrae more numerous than abdominal, vertebrae 19+24–25=43–44; peduncular vertebrae 17.

**DISTRIBUTION.**— *Dolichamphilius brieni* is known only from the type locality, Stanley Pool [Congo River at Kinshasa].

## MATERIAL EXAMINED

**TYPE MATERIAL.**— REPUBLIC DU CONGO (KINSHASA): MRAC 118504–118506, 26.9 mm, Stanley Pool, extérieur des îles de l’archipel N’Djili vers l’île de Cristal, 7 Oct. 1957, P. Brien, M. Poll, J. Bouillon (paratype); MRAC 118504, 31.2 mm, Stanley Pool, passe devant le refuge Jipo, 7 Oct. 1957, P. Brien, M. Poll, J. Bouillon (paratype; cleared and stained with alcian and alizarin).

## ADDITIONAL MATERIAL EXAMINED

None; species known only from type specimens.

**“*Dolichamphilius*” *longiceps* Roberts, new species**

(Fig. 16c)

**HOLOTYPE.**—REPUBLIC DU CONGO (KINSHASA): MRAC 90–47–P–704–708, 42.2 mm, Chutes Wagenia, Kisangani, 24 June 1991, L. De Vos.

**DIAGNOSIS.**— Dorsal fin rays i5½; anal fin rays iii7; pectoral fin rays i9. Caudal fin rays 10,6+7,12. Vertebrae 20+20=40; 6 pairs of ribs. First pair of ribs, on vertebra 5, smaller than ribs on vertebra 6 (in all other leptoglanins, first pair of ribs are largest and occur on vertebra 6). Caudal peduncle elongate, but much less so than in *D. brieni*, with only 12 vertebrae. Body with four or five elongate oval spots centered on midline; spot nearest middle of body considerably enlarged on

both sides of body in holotype would be a diagnostic feature if characteristic of the species.

**COMMENTS.**— This distinctive species is unfortunately known only from the holotype, which has been radiographed but not cleared and stained for osteology. It resembles in some ways the species of *Tetracamphilius* but differs from them in having simple conical jaw teeth and more numerous vertebrae. It is provisionally assigned to *Dolichamphilius*, even though it differs in several respects from the generic type species. Because of doubt that this species belongs to *Dolichamphilius*, its characters have not been taken into account in the diagnosis of *Dolichamphilius*.

**DISTRIBUTION.**— *Dolichamphilius longiceps* is known only from the type locality, Chutes Wagenia on the R. Lualaba near Kisangani.

**ETYMOLOGY.**— The name *longiceps* is from the Latin, *longus*, long; and *-ceps*, derived from *caput*, head.

### *Psammphiletria* Roberts, new genus

Type species: *Psammphiletria nasuta* Roberts, new species.

**DIAGNOSIS.**— Small, sand-dwelling amphiliid catfishes (largest known specimen 23.7 mm) with a prominent fleshy rhinal lobe; basal half of maxillary barbel included in maxillary membrane; branchiostegal rays 4–5; tubiferous portion of lateral line incomplete, ending above anal fin; dorsal and pectoral fins without locking mechanisms, their fin rays all slender and flexible; dorsal fin origin very far behind head and pectoral fin, over vertebra 11–13; adipose fin triangular, moderately elongate, its origin over base of third anal fin ray; 3–4 pairs of ribs; pectoral- and pelvic-fin branched rays with long simple branches medially and extremely foreshortened compound branches distally (this character is shared with *Dolichamphilius*); pelvic fin origin below vertebra 10–11; principal caudal fin rays 5/6; lower lobe of caudal fin distinctly prolonged; vertebrae 17–18+16–18=33–36; neural and hemal spines expanded distally (lamellar).

**COLORATION.**— Head and body overall white, translucent but not transparent. There is an almost continuous median row of brown spots or marks on the dorsal surface of the body. Head, fins, and side of body without markings except for a diamond-shaped peduncular spot and some smaller indistinct markings just anterior to it.

**COMMENTS.**— *Psammphiletria* looks superficially like the young of *Amphilius*, but there are numerous differences. *Amphilius* differs from *Psammphiletria* in having no rhinal lobe; anterior and posterior cranial fontanelles present; branchiostegal rays 6–8; gill rakers present on upper portion of gill arches (absent in *Psammphiletria*); 10 or more pairs of ribs; pelvic fin origin very much farther posterior; pectoral girdle with two ossified radials instead of only one; principal caudal fin rays 6+7 or more; lower caudal fin lobe not prolonged.

*Zaireichthys* differs in having very stout dorsal and pectoral fin spines with well-developed locking mechanisms; serrate pectoral fin spine; principal caudal fin rays always more than 5+6; and procurrent caudal fin rays much more numerous. *Dolichamphilius* differs in having a more elongate body, more numerous vertebrae, dorsal fin origin immediately behind cranium; pectoral fin with 11–12 rays; first branched ray of pectoral and pelvic fins prolonged.

**ETYMOLOGY.**— From the Greek *psammo* “sand” and *philetria* “lover of”. Gender feminine.

### *Psammphiletria nasuta* Roberts, new species

(Figs. 8f, 9d, 17a–d)

**HOLOTYPE.**— REPUBLIQUE CENTRAFRICAINE: CAS 92624, 23.5 mm, Central African Republic,

sandy riffle in R. Ubangui near Banda, 72 km upriver from Bangui, 5 March 1988, T.R. Roberts.

**DIAGNOSIS.**—A species of *Psammphyletria* with 4–6 unbranched anal fin rays. Dorsal fin with only 5 rays; dorsal fin pterygiophores 4. Rhinal lobe very large. Gill rakers on first gill arch 3–4. Vertebrae 18+17–18=34–36.

**DISTRIBUTION.**—*Psammphyletria nasuta* is known only from the Ubangui River upstream from Bangui.

**ETYMOLOGY.**—The name *nasuta* is from the Latin *nasutus*, long-nosed.

#### MATERIAL EXAMINED

**HOLOTYPE.**—REPUBLIQUE CENTRAFRICAINE: CAS 92624, 23.5 mm, Central African Republic, sandy riffle in R. Ubangui near Banda, 72 km upriver from Bangui, 5 March 1988, T.R. Roberts.

**PARATYPES.**—REPUBLIQUE CENTRAFRICAINE: CAS 92625, 11:14.8–22.7 mm, same data as holotype (3:16.1–23.7 mm cleared and stained with alcian and alizarin); CAS 92626, 16.5 mm, R. Ubangui at Isle Basiki, 75 km upriver from Bangui, 6 March 1988, T. R. Roberts.

#### *Psammphyletria delicata* Roberts, new species

(Fig. 17e)

**HOLOTYPE.**—MRAC 118455, 20.5 mm, Stanley Pool, 27 Sept. 1957, P. Brien, M. Poll, J. Bouillon.

**DIAGNOSIS.**—*Psammphyletria delicata* is distinguished from *P. nasuta*, its only congener, by slight differences in counts of dorsal and anal fin rays, and in having dorsal and anal fin pterygiophores and laminar portions of neural and hemal spines more expanded. Dorsal fin rays 7 (5 in *P. nasuta*). Dorsal fin pterygiophores 7 (4 in *P. nasuta*). All three type specimens have anal fin with three simple rays, three branched rays, and a simple ray (last simple ray only ray on last anal fin pterygiophore). Rhinal lobe large, but not so large as in *P. nasutus*; this may be partly due to differences in preservation and condition of the specimens, those of *P. delicata* being in less good condition. Vertebral count of the single cleared and stained paratype 17+16=33.

**DISTRIBUTION.**—*Psammphyletria delicata* is known only from Stanley Pool (Malebo Pool).

**ETYMOLOGY.**—The trivial name *delicata* is Latin for dainty or delicate.

#### MATERIAL EXAMINED

**HOLOTYPE.**—MRAC 118455, 20.5 mm, Stanley Pool, 27 Sept. 1957, P. Brien, M. Poll, J. Bouillon.

**PARATYPES.**—MRAC 118456, 19.5 mm, same data as holotype (cleared and stained with alcian and alizarin); MRAC 118489, 18.6 mm, Stanley Pool, passe devant la refuge Jipo, 17 Oct. 1957, P. Brien, M. Poll, J. Bouillon.

#### *Tetracamphilius* Roberts, new genus

Type species: *Tetracamphilius pectinatus* Roberts, new species.

**DIAGNOSIS.**—*Tetracamphilius* differs from all other leptoglanins and from all other amphiliids in having pedicellate jaw teeth with a fan-shaped distal end typically armed with two to six tiny flattened triangular cusps (Fig. 19). All other amphiliids have simple conical jaw teeth or jaw teeth absent. Adipose fin triangulate, its origin well in advance of a vertical line through anal fin origin. Caudal peduncle slender, peduncular vertebrae 9–12. Caudal fin deeply forked, lower lobe slightly larger than upper, principal caudal fin rays 6+7.

COMMENTS.—The cusps on the jaw teeth of *Tetracamphilius* are possibly unique not only in catfishes but perhaps also in Ostariophysii. I do not know of any other catfishes with comparable cusps. Multicuspid characoid jaw teeth are superficially similar but are much larger, and usually formed by combination of individual conical elements (Roberts 1967b), which does not appear to be so in *Tetracamphilius*. Scanning electron microscopic observations of the jaw teeth in a specimen of *T. pectinatus* reveals that the cusps are flattened, not really conical, and that they are frequently broken off, so that it is difficult to find a tooth with more than one or two intact cusps; many of the teeth have all of the cusps broken off, so that they are squared off distally or peg-like in shape. The number of cusps increases with growth. The largest cleared and stained specimen examined, a 37.2 mm *T. angustifrons*, had jaw teeth with as many as six cusps. When the cusps of such a tooth are broken off, the crown has a discoid shape. The multicuspid teeth of *Tetracamphilius* are present on the upper as well as lower jaw, but not in the pharynx (upper and lower pharyngeal teeth in all leptoglanins including *Tetracamphilius* are simple conical teeth).

ETYMOLOGY.—From the Greek *tetra*, four, and *akis*, point, in reference to the multicuspid teeth, and *Amphilius*, a generic name for this group of catfishes.

#### KEY TO SPECIES OF *TETRACAMPHILIUS*

Some meristic and other characters distinguishing the species of *Tetracamphilius*, presented in Table 4, should be used in conjunction with this key.

1. Pectoral fin spine without serrae; body spotted . . . . . 2  
Pectoral fin spine with fine serrae on inner margin; body with dark-margined, pale-centered bands . . . . . *T. pectinatus*
2. Lamellar portion of olfactory organ large, its length nearly equal to eye diameter; posterior nares much larger than anterior nares . . . . . 3  
Lamellar portion of olfactory organ not enlarged, its length less than half eye diameter; anterior and posterior nares equal in size . . . . . *T. notatus*
3. Dorsal fin rays 8–9; anal fin rays 9–10; pectoral fin rays 8–9 . . . . . *T. angustifrons*  
Dorsal fin rays 6–7; anal fin rays 8; pectoral fin rays 7–8 . . . . . *T. clandestinus*

TABLE 4. Comparison of the species of *Tetracamphilius*

	<i>pectinatus</i>	<i>angustifrons</i>	<i>clandestinus</i>	<i>notatus</i>
pectoral spine serrae	6-7	-	-	-
pectoral fin rays	8-9	9	7-8	8
dorsal fin rays	8-9	6-7	6-7	8
anal fin rays	8-10	9-10	8	10
procurrent caudal fin rays	13-14/13-14	9-11/10-12	9-12/9-10	13/11
branchiostegal rays	7-8	6-7	6-7	6-7
ribs	4	4-5	3-4	5
total vertebrae	34-38	36-38	35	35-37
largest specimen (mm SL)	33.7	39.4	19.5	32.5

*Tetracamphilius pectinatus*, Roberts, new species

(Figs. 18)

**HOLOTYPE.**— REPUBLIC DU CONGO (KINSHASA): CAS 92627, 33.7 mm gravid female, Congo basin, tributary of R. Luala 26 km N of Kibunzi (8 km S of turnoff to Kibunzi, Luozi dist.), 45°6.5' S, 13°48' E, 24 July and 17 Aug. 1973, T.R. Roberts and D.J. Stewart.

**DIAGNOSIS.**— *Tetracamphilius pectinatus* differs from the other species of the genus and from all other amphiliids except *Zaireichthys* in having a serrated pectoral fin spine. Unlike *Zaireichthys*, which has very large pectoral spine serrae, the serrae are very small, and the pectoral fin spine does not possess a locking mechanism. It differs from all other leptoglanins (and all other amphiliids) except *Z. zonatus* in having color pattern with a series of bands with paler inner part and darkened margins.

**COLORATION IN LIFE.**— *Tetracamphilius pectinatus* is the most colorful known leptoglanin. In life, the dark narrow bands are a dark chocolate brown, the dorsum of the head and areas between the narrow bands tan or orangish tan, and the abdomen and other pale areas cream-colored.

**HABITAT NOTES.**— The tributary of the rivière Luala in Bas-Congo where adult *T. pectinatus* were collected in breeding condition was clear, moderately swift flowing, with sand, gravel, and rock rubble bottom, 6–8 m wide and 1 m deep, in rolling or hilly savannah. On 24 July 1973 collecting was done with a square frame net, by pushing it into the sandy or other bottom, or by holding it in place and kicking rocky rubble and gravel 1–3 m upstream from it. Some 8 specimens of *T. pectinatus* were collected together with ornately banded mochokid catfish, *Chiloglanis reticulatus* Roberts, 1989, along the interface of sand and gravel. A second mochokid species, the mottled *C. batesii* Boulenger, 1904, was collected only in rocky rubble and riffles along with a species of the rheophilic cyprinid genus *Garra*. No other catfishes were collected at this locality. On 17 August 1973 a larger collection was made at the same spot using toxaphene.

**DISTRIBUTION.**— *Tetracamphilius pectinatus* is known from the mainstream of the Ubangui upstream from Bangui, from a small tributary of the rivière Luala in the Lower Congo basin (Bas-Congo), and from the Luala in southern Congo (Kasai).

**ETYMOLOGY.**— The trivial name *pectinatus* is Latin for comb-like, in reference to the small serrations on the pectoral fin.

## MATERIAL EXAMINED

**HOLOTYPE.**— REPUBLIC DU CONGO (KINSHASA): CAS 92627, 33.7 mm gravid female, Congo basin, tributary of R. Luala 26 km N of Kibunzi (8 km S of turnoff to Kibunzi, Luozi dist.), 45°6.5' S, 13°48' E, 24 July and 17 Aug. 1973, T. R. Roberts and D. J. Stewart.

**PARATYPES.**— REPUBLIQUE CENTRAFRICAINE: CAS 92628, 31:26.3–33.7 mm, collected with the holotype (3:27.4–29.2 mm cleared and stained with alcian and alizarin; 7:26.3–29.6 mm, cleared and stained with alizarin); CAS 92629, 2:23.4–24.5 mm, R. Ubangui, riffles in sand bar at Isle Basiki, 75 km upstream from Bangui, 6 March 1988, T. R. Roberts; CAS 92630, 5:21.2–26.3 mm, R. Ubangui, riffles in shallow sandy area near Banda, 72 km upstream from Bangui, 5 March 1988, T. R. Roberts (2:21.9–24.0 mm cleared and stained with alcian and alizarin); CAS 92631, 23.3 mm, R. Ubangui upstream from Bangui, 1 March 1988. REPUBLIC DU CONGO (KINSHASA): T. R. Roberts; CAS 92632, 28.6 mm, R. Lulua just below Chutes de Mbombo, near Luluaburg [=Kananga], 7 Sept. 1986, T. R. Roberts.



***Tetracamphilius angustifrons* (Boulenger, 1902), new comb.**

(Figs. 19, 20a)

*Anoplopterus angustifrons* Boulenger, 1902:42, pl. 10 fig. 4 (type locality "Banzyville" [=Mobaye, on the rivière Ubangui]).

*Amphilius angustifrons* Boulenger, 1911:362, fig. 282.

**DIAGNOSIS.**—A *Tetracamphilius* differing from all other species except *T. clandestinus* in having a relatively elongate snout with an enlarged olfactory organ; length of lamellar portion of olfactory organ nearly equal to eye diameter; and anterior and posterior nostrils widely separated, posterior much larger than anterior. From *T. clandestinus* it differs in having more dorsal fin rays (8–9 vs. 6–7; more anal fin rays (9–10 vs 7–8); and more pectoral fin rays (9 vs 7–8).

**NOTES ON SYNTYPES.**—BMNH and MRAC syntypes are all in very poor condition. Probably they were accidentally dried when the species was being described, because the drawing of the whole specimen evidently was based on a specimen in very good condition, while the drawing of the dorsal view of the head evidently was based on a specimen that had dried. This apparently led to the erroneous illustration of the posterior nostrils and the statement "posterior nostril midway between eye and end of snout" (Boulenger 1911:362). On the MRAC syntype I did not find posterior nasal openings in the position indicated by Boulenger. I found the large posterior nostril only after careful searching with fine forceps. The openings were tightly pressed to the dorsal surface of the lateral ethmoids, only slightly in advance of the eyes, and were very difficult to see until gently lifted.

*Amphilius angustifrons* was known only from the original series of 5 syntypes, from the Ubangui River near Banzyville (near Bangui), all of them now in very poor condition (Skelton, 1986: 266; present observations). Judging from the original figure, at least one of the specimens was in good condition when studied by Boulenger (1902; 1911).

One of the two BMNH syntypes was cleared and stained for this study. The preparation was not satisfactory, however. Bone and cartilage stained well, but soft tissues were stained deep blackish blue. The specimen broke into pieces, and some bits were lost. The caudal fin skeleton and most of the fins rays disintegrated. The head has been dissected and sketches and observations made on the jaws, vomer, gill arches, branchiostegal rays, and auditory capsules. The multicuspid jaw teeth (most fallen out) were observed and drawn. In this specimen, the multicuspid jaw teeth included individual teeth with up to 6 cusps; teeth with the cusps all broken off are left with broadly rounded distal ends. Vertebral counts were obtained from radiographs of three syntypes.

**REMARKS ON IDENTIFICATION OF SPECIMENS.**— Identification of freshly collected material from Ubangui as *T. angustifrons* is based mainly on direct comparison with one of the syntypes, a larger specimen in very poor condition. Identification of the specimens from the Chutes Wagenia is problematic. The head is narrow anteriorly, as in *T. angustifrons*, but the color pattern is somewhat more like that of specimens identified as *T. notatus*. The eyes are smaller than in specimens identified as *T. angustifrons* or *T. notatus*. If correctly identified, these are the only specimens of *T. angustifrons* known from a locality other than the Ubangui.

**DISTRIBUTION.**—*Tetracamphilius angustifrons* is known only from the Ubangui mainstream above Bangui, with the exception of one lot of specimens tentatively identified as *T. angustifrons* from the Chutes Wagenia, Lualaba.

## MATERIAL EXAMINED

**TYPE MATERIAL.**—REPUBLIC DU CONGO (KINSHASA): MRAC 1313, 39.4 mm, Banzyville, 1901, Royaux (syntype; the other specimen from this lot, 19.8 mm, has been reidentified as

*Zaireichthys mandevillei*); BMNH 1901.12.27.40, 37.2 mm, Banzyville, 1901, Royaux (syntype; cleared and stained with alcian and alizarin, but specimen did not clear and disintegrated, see below).

#### ADDITIONAL MATERIAL EXAMINED

REPUBLIQUE CENTRAFRICAINE: CAS 92633, 9:17.4–31.7 mm, R. Ubangui at Isle Molinge, 82 km upstream from Bangui, 27 Feb. and 7 March 1988, T.R. Roberts; CAS 92634, 6:17.4–27.3 mm, R. Ubangui at Isle Basiki, 75 km upstream from Bangui, 6 March 1988, T.R. Roberts; CAS 92652, 6:18.0–24.8 mm, sandy riffle in R. Ubangui near Banda, 72 km upriver from Bangui, 5 March 1988, T.R. Roberts (cleared and stained with alcian and alizarin); CAS 92635, 15:15.2–26.6 mm, R. Ubangui in shallow sandy area at Bawili, 68–69 km upstream from Bangui, 5 March 1988, T.R. Roberts. REPUBLIC DU CONGO (KINSHASA): MRAC 90–47–P–704–708, 4:26.0–29.3 mm, Congo River in Chutes Wagania near Kisangani, 24 June 1990, L. De Vos.

#### *Tetracamphilius clandestinus* Roberts, new species

(Fig. 20b)

**HOLOTYPE.**— REPUBLIQUE CENTRAFRICAINE: CAS 92653, 17.8 mm, riffles in shallow sandy area of Ubangui near Banda, 72 km upstream from Bangui, 5 March 1988, T. R. Roberts.

**DIAGNOSIS.**— *Tetracamphilius clandestinus*, with largest known specimen 19.5 mm, is perhaps the smallest leptoglanin species. It is very similar to *T. angustifrons* but has slightly fewer vertebrae, ribs, dorsal and pectoral fin rays, and differently shaped auditory capsules. Dorsal branched fin rays 5 or 5½ (6½ or 7½ in *T. angustifrons*). Pectoral fin branched fin rays 6 or 7 (usually 8, very rarely 7 or 9 in *T. angustifrons*). Usually 3 pairs of ribs, sometimes 4 (usually 5 pairs of ribs, sometimes 4 in *T. angustifrons*). In *T. clandestinus* and *T. angustifrons* of the same size, the fleshy rostrum usually is more pronounced in *T. clandestinus*. Total vertebrae 17+18=35 in five cleared and stained paratypes (*T. angustifrons* and other species of *Tetracamphilius* usually with 36 or more vertebrae; Table 1). Consult diagnosis of *T. angustifrons*.

**DISTRIBUTION.**— *Tetracamphilius clandestinus* is known only from the Ubangui mainstream above Bangui.

**ETYMOLOGY.**— The trivial name *clandestinus* is Latin, meaning secret or hidden.

#### MATERIAL EXAMINED

**HOLOTYPE.**— REPUBLIQUE CENTRAFRICAINE: CAS 92653, 17.8 mm, riffles in shallow sandy area of Ubangui near Banda, 72 km upstream from Bangui, 5 March 1988, T.R. Roberts.

**PARATYPES.**— REPUBLIQUE CENTRAFRICAINE: CAS 92654, 22:14.4–19.5 mm, collected with the holotype (5:17.3–19.2 mm cleared and stained with alcian and alizarin); CAS 92655, 2:15.2–15.7 mm, R. Ubangui near Bawili, 68–69 km upstream from Bangui, 5 March 1988, T.R. Roberts.

#### *Tetracamphilius notatus* (Nichols & Griscom, 1917), new comb.

(Fig. 20c)

*Amphilius notatus* Nichols & Griscom, 1917:715, fig. 24 (type locality Faradje [=R. Uele, a large tributary of the Ubangui]).

**DIAGNOSIS.**— A *Tetracamphilius* species with non-serrate pectoral fin spines, spots instead of bands on the body, and olfactory organ not greatly enlarged.

**REMARKS ON IDENTIFICATION OF SPECIMENS.**— This species was known only from the holotype. Specimens from the Chinko and the Mbomou were identified as *T. notatus* by comparing them directly with the holotype. Holotype has dorsal fin rays  $i6\frac{1}{2}$ , anal  $ii7\frac{1}{2}$ , pectoral  $i8/i7$ , caudal  $14.6/7.13$ . Color pattern evidently has faded somewhat, but melanophores are still visible and the original color pattern is therefore discernible. All features of color pattern identical with those in freshly preserved specimens.

**DISTRIBUTION.**— *Tetracamphilius notatus* is known from the mainstream of the Ubangui, from several of its larger and smaller tributaries, and from the R. Lufira in eastern Congo.

### MATERIAL EXAMINED

**TYPE MATERIAL.**— REPUBLIC DU CONGO (KINSHASA): AMNH 6711, 28.5 mm, Faradje, Jan. 1913. Lang and Chapin (holotype).

### ADDITIONAL MATERIAL EXAMINED

REPUBLIQUE CENTRAFRICAINE: CAS 92656, 2:24.9–26.7 mm, R. Chinko at Rafai, Republique Centrafricaine, 30 Jan. 1987, T.R. Roberts (25.9 mm cleared and stained); CAS 92657, 25.2 mm, rapids in R. Mbomou about 10 km SW of Rafai, Republique Centrafricaine, 1 Feb. 1987, T.R. Roberts; CAS 92658, 19.1 mm, R. Ubangui, riffles in sand bar at Isle Basiki, 75 km upstream from Bangui, 6 March 1988, T.R. Roberts; CAS 92659, 4:15.8–24.2 mm, R. Ubangui, riffles in sandy shallow area near Banda, 72 km upstream from Bangui, 5 March 1988, T.R. Roberts; CAS 92650, 23.9 mm, R. Ngougoufon near where it flows into R. Topia, about 120 km due E of Berberati, 23 March 1988, T.R. Roberts. REPUBLIC DU CONGO (KINSHASA): MRAC 87–61–P–3, 32.5 mm, Kilwezi, affluent droit, de la rivière Lufira, alt. 800 m, 30 Aug. 1948, G.F. de Witte.

### OSTEOLOGY

This is a summary account of leptoglanin osteology. Adequate drawings for a reasonably full osteological account of even a single species have not been completed. This is due to the inordinate amount of time and effort involved. A comprehensive osteological account of just the cranium of one species should include four drawings: dorsal, ventral, lateral, and occipital view. A full set of osteological drawings for one species would involve 15 or more figures. A comprehensive osteological account of Leptoglaninae, including descriptions, comparisons, and analysis of relationships just within Leptoglaninae and Amphiliidae, could easily run to 100 pages.

Enough leptoglanin osteology is presented here to introduce the topic. It is intended to permit discussion of morphological trends within Leptoglaninae. It may also be useful in discussions of relationships within Amphiliidae. Ichthyologists primarily interested in the catfishes of Asia and South America recently have investigated the possible relationships of Amphiliidae and Leptoglaninae to various South American and Asian catfish families, in particular to the Asian family Sisoridae (Pinna 1996; He and Meunier 1998; He et al. 1999). This is beyond the scope of this paper.

The osteological features of Leptoglaninae showing the greatest diversity and specialization are the cranium, jaws and dentition, pectoral fin girdle, and axial skeleton. The jaws of *Leptoglanis xenognathus* are perhaps most specialized, but the palatine arch appears to be generalized (Figs. 4–7). In Leptoglaninae, teeth are found only on the jaws and pharyngeal arch. The multicupid jaw teeth of the genus *Tetracamphilius* are a notable specialization, especially for such small species, but the palatine arch of *Tetracamphilius* (Fig. 19) and pharyngeal arches are relatively generalized. The pharyngeal teeth are large and conical, not multicupid. The gill arches of Leptoglaninae, char-

acterized by reduced gill rakers, appear to be morphologically generalized and relatively unspecialized. Those of *Leptoglanis* (Fig. 8b) are morphologically very similar to those of *Zaireichthys* (Fig. 8c–e). The hyoid arch also appears to be relatively generalized and exhibits little osteological variation. Catfish families (e.g., Bagridae, Schilbeidae) often exhibit considerable range in the number of branchiostegal rays. Leptoglaninae all have 4–8 branchiostegal rays. The lowest observed count of 4 occurs in the tiny species *Psammphyletria nasuta*; the highest counts of 6–8 occur in the largest species *Leptoglanis xenognathus*.

The pectoral fin girdle, as in catfishes generally, comprises three main bony elements: postem-poral-supracleithrum, scapulocoracoid, and cleithrum (Diogo et al. 2001). There are also a meso-coracoid bone, a cartilaginous complex radial, and a single bony proximal radial. Some catfishes families, such as the African Claroteidae and Asian Bagridae, normally have two bony proximal radials, but Amphiliidae including Leptoglaninae usually have only one (Fig. 9a–b). This nomenclature follows Diogo et al. (2001) and authors cited therein. Much of the variation in leptoglanin pectoral girdle morphology (Fig. 9a–c) evidently is related to the variation in pectoral fin spines from stout, rigid, and serrate to slender, flexible, and non-serrate, and the corresponding presence or absence of a mechanism to lock the pectoral fin spine in erect position.

The paired fins, dorsal fin, and caudal fin show great variety of structure and numerous specializations. This is of course reflected in their girdles and other bony supporting structures.

One outstanding feature is the presence of dorsal and pectoral fin spines with locking mechanisms in *Zaireichthys*. In this genus the pectoral fin spine is also strongly serrate. All other leptoglanins lack locking mechanisms for the dorsal and pectoral spines, and only one other species, *Tetracamphilus pectinatus*, has a serrated pectoral fin spine (Fig. 9c). In *Psammphyletria* the pectoral fins rays are morphologically virtually the same as the pelvic fin rays. These fish effectively have two pairs of pelvic fins, an anterior pair (the pectoral fins) and a posterior pair (the true pelvic fins).

The axial skeleton exhibits numerous striking morphological differences. The range of vertebral counts from 33 to 44 is only a pale reflection of this. In some species of *Zaireichthys* the neural and hemal spines are relatively slender and morphologically generalized (Figs. 5c, 9–11b). In *Leptoglanis*, *Dolicamphilus*, and *Psammphyletria*, on the other hand, these processes are hugely expanded and morphologically highly specialized (Figs. 1d; 12; 13d–e; 16a,c). *Tetracamphilus* and some species of *Zaireichthys* are intermediate in this respect (Figs. 11a, 14b). The degree of specialization of the dorsal and anal fin pterygiophores is correlated closely with that of the neural and hemal processes (Figs. 1d; 5c; 9; 10c; 11; 12a,b; 13d–e; 14; 16a,c).

The caudal fin ray formulas of leptoglanins exhibit a remarkable range of principal fin ray counts, from 7/8 in *Leptoglanis xenognathus* and *Zaireichthys rotundiceps* down to 5/6 in *Psammphyletria* (Table 1). Caudal fin shape also varies markedly, from deeply forked, moderately forked, truncate or rounded (Figs. 1c; 5b; 9; 10b; 11; 12a–b; 13c,e; 14; 16).

Despite these great differences in the caudal fin shape and ray counts, the caudal fin skeleton shows remarkably little morphological variation (Figs. 1d; 5c; 9; 10c; 11a,b; 12a; 13d,e; 14b; 16c). It consists mainly of a single upper and single lower hypurals. Sometimes the two elements are entirely separate, as in *L. xenognathus* (Fig. 1d). They may be partially fused, as in species of *Tetracamphilus* (Figs. 14b, 16a,c), or entirely fused, as in *Psammphyletria* (Figs. 13d,e). The primitive principal caudal fin count in catfishes is 8/9 (Lundberg and Baskin 1969). This number occurs in several species of *Amphilus* and other Amphiliinae (Table 1). It is reasonable to assume that 7/8 is the most primitive caudal fin ray count in leptoglanins. This primitive count, however, does not appear to be associated with an equally primitive arrangement of the caudal fin skeleton. In leptoglanins the caudal fin skeleton consists mainly of a single upper and single lower hypural ele-

ment. This may indicate that the presence of 7/8 principal caudal fin rays in *Leptoglanis* and in one species of *Zaireichthys* is due to independent re-expression of a primitive catfish character trait. The dorsal and pectoral fin spine locking mechanisms and pectoral fin spine serrae of *Zaireichthys* may be further examples of the same phenomenon.

## DISCUSSION

**AFRICAN CATFISH FAMILIES AND LEPTOGLANINAE.**— The freshwater catfishes of Africa currently are classified in seven families: Bagridae, Claroteidae, Mochokidae, Schilbeidae, Clariidae, Malapteruridae and Amphiliidae. Their phylogenetic relationships and higher classification are not well understood. All members of the first four families generally differ from Leptoglaninae and agree with each other in sharing the primitive catfish characteristics of the defensive tripod, an unencapsulated swim bladder, and 8/9 principal fin rays. The defensive tripod, an effective anti-predator device, consists of more or less stout, serrated dorsal and pectoral fin spines that can be locked in erect position. Bagridae is a large family present only in Africa and Asia. The large endemic African family Claroteidae was recently removed from Bagridae (Mo 1991). Thus African Bagridae now includes only the endemic African genus *Bagrus*. *Bagrus* differs from all other bagrids, from Claroteidae, and from all other African catfishes in having a dorsal fin with 10-11 soft rays. There are only six or seven species. They are all large, with flat head and long barbels. Claroteidae, Mochokidae, and Schilbeidae, with diverse head and body shape, usually have 7 soft dorsal fin rays. The exclusively African Mochokidae have highly specialized jaws with pedicellate multicupid teeth for browsing on algae, and strongly branched barbels. No other African catfishes have branched barbels. Osteological characters of Mochokidae, especially of the jaws, cranium, and pectoral girdle, indicate that they probably are related to the Auchenoglanidinae, a subfamily presently assigned to Claroteidae. Close relationship between Mochokidae and Doradidae, a South American family with branched barbels, seems unlikely. Schilbeidae and Clariidae are shared by Africa and Asia. Schilbeidae all have a laterally compressed body, a very long anal fin, and long barbels. Clariidae are distinguished from all other African catfishes by having a more or less elongate, eel-like body form and eel-like locomotion and a highly apomorphic cranium. Clariid pectoral fins have a stout serrated spine with a mechanism to lock it into erect condition, but the dorsal fin is entirely soft-rayed. The clariid dorsal fin has numerous rays, and extends the entire length of the body, unless interrupted posteriorly by the adipose fin. Then the dorsal fin with the adipose fin extends virtually the entire length of the body. The caudal fin invariably is rounded. Given the distinctive and specialized characteristics of Mochokidae, Schilbeidae, Clariidae, and Malapteruridae, it is difficult to sustain hypotheses of close relationships between any of them and Leptoglaninae.

The most viable hypothesis of a close relationship between Leptoglaninae and another family of African catfishes is with Amphiliidae. Leptoglaninae agrees with Amphiliidae and differs from other African catfish groups in two major ways: (1) absence of the defensive tripod (except in *Zaireichthys*); and (2) bony encapsulation of the swim bladder. The hypothesis of Amphiliidae-Leptoglaninae relationship is strengthened by presence of a "transverse interscapular bony bridge" in *Andersonia leptura* (He 1999; pers. obser.), a member of the rheophilic amphiliid subfamily Doumeinae. Apart from *Andersonia*, this character is known only in Leptoglaninae. Leptoglaninae differs from the two other amphiliid subfamilies, Amphiliinae and Doumeinae, in having an entirely different life style and in lacking unculiferous pads on the ventral surface of their paired fins. *Andersonia* is a highly specialized plated doumein, present in the Nile and other Sudanic drainage systems. It is not closely related to Leptoglaninae. The possibility that Amphiliidae or

Leptoglaninae might be closely related to South American or Asian catfishes is beyond the scope of the present work.

**PLEOMERISM IN LEPTOGLANINAE.**—Pleomerism, the tendency among related fish species for vertebral number to be correlated with maximum body length (Lindsey 1975), has been documented in several catfish families: Lindsey (1975; Ictaluridae and Mochokidae); Roberts (1983; sisorid genus *Baqarius*); Roberts and Vidthayanon (1991; Pangasiidae). The phenomenon often can be used by catfish systematists to distinguish closely related species differing in size. It may sometimes prove useful in predicting adult size of species known only from very small or immature specimens, and in detecting valid species formerly placed in synonymy (Lindsey 1975). Maximum standard length of leptoglanins ranges from a little under 20 mm to 65 mm (consult material examined) and total number of vertebrae from 34 to 44 (Table 2).

To simplify the present discussion, leptoglanins may be divided into four size classes: 1) less than 20 mm; 2) 20–30 mm; 3) 30–50 mm; and 4) over 50 mm. The ranges of total vertebral counts recorded for these classes are, respectively, 35 (only a single species, *T. clandestinus*); 34–37 (six species); 34–44 (six species); and 38–41 (only a single species, *Leptoglanis xenognathus*).

It may be noted that 34 is close to the lowest known vertebral count recorded in catfishes.

The very lowest vertebral counts in *P. delicata* (33), *Z. zonatus* (34), and *T. clandestinus* (35) indicate that these probably are indeed very small species. The highest counts, 43–44 in *Dolichamphilius brieni*, may indicate that this very rare species gets considerably larger than the 26.9–31.2 mm standard length of the only two specimens known. This count is also almost certainly related to the exceptionally elongate or slender body of this species (see discussion of relationship between pleomerism and body elongation in Lindsey, 1975). While the number of abdominal vertebrae (19) is not exceptional, the numbers of postabdominal vertebrae (24–25) and peduncular vertebrae (17) are the highest found in Leptoglaninae. The only known species that might be congeneric with *D. brieni*, *D. longiceps*, has a less elongate body with only 40 vertebrae.

The lowest total vertebral counts recorded in Leptoglaninae occur in the smallest species, *P. delicatus* (33), and in the stoutest species, *Z. heterurus* (33–34).

**ZOOGEOGRAPHY OF LEPTOGLANINAE.**—The geographical distribution of Leptoglaninae contrasts strikingly with that of the two other amphiliid subfamilies. Basic information on distribution of Amphiliidae is provided by Skelton and Teugels (1986). All three subfamilies are well represented in the Congo basin. Amphiliinae occur throughout virtually all of tropical Africa, including the Upper and Lower Guinean coastal areas, the Ogooué basin, Angolan coastal basins, and most of eastern and southern Africa. Doumeinae also occur in Upper and Lower Guinea, the Ogooué, and Angolan coastal basins, but are absent in southern and eastern Africa.

The only leptoglanin known from north of the Congo basin, *Zaireichthys camerunensis*, has been reported only from the Niger basin (Risch 1992). The Niger basin is part of the Nilo-Sudanic ichthyofaunal province recognized by Roberts (1975). It embraces the Nile, Chad, Niger, Senegal and Volta basins. Most Nilo-Sudanic fish genera occur in all of these basins, and further collecting may result in discovery of *Z. camerunensis* in other Nilo-Sudanic drainages. It is highly unusual for an essentially Congolese fish group to have close phyletic relationship to fishes otherwise found only in the Niger basin. Another instance of disjunct distribution involving Nilo-Sudanic and Congolese fishes is provided by the rheophilic cichlid genus *Steatocranus*, with six endemic species in the Congo basin and one in the Volta basin (Roberts and Stewart 1976).

The striking difference in the distribution patterns of Amphiliinae and Doumeinae versus Leptoglaninae may well lay in their different habitat preferences. Amphiliinae and Doumeinae are current-loving or rheophilic fishes typically living in high gradient streams with rocky substrate. They often occur at high elevations in mountain streams, and some species may be classed among

the oribatic or mountain-loving African fishes (Roberts 1975). Such fishes often occur in separate drainages on opposite sides of drainage divides, possibly because of numerous stream captures as mountain tops are eroded by their drainages. Leptoglaninae, on the other hand, are nearly all restricted to very large lowland streams, inhabiting extensive low-gradient areas where the substrate is predominantly or entirely fine sand. Such species are unlikely to cross over mountain divides. On the other hand, they are likely to have very extensive ranges within any particular river basin, as indeed seems to be so for several Congolese leptoglanins. *Leptoglanis xenognathus* and *Zaireichthys maudevillei* are known from the Lower Congo (Stanley Pool), Ubangui, and Lualaba. *Tetracauphilius pectinatus* also has an extensive range within the Congo basin.

**A SPECIALIZED LIFESTYLE.**— This account of Leptoglaninae may be concluded by a consideration of the unusual "lifestyle" of the more specialized taxa. We are concerned here with all of the species in the genera *Leptoglanis*, *Dolichamphilius*, and *Psammophyletria*, two species of *Tetracauphilius*, and one of *Zaireichthys*. These are all small or very small species. The largest known specimen of *Leptoglanis* is 65 mm and the largest known *Dolichamphilius* only 32 mm. *Psammophyletria uasuta* reaches only 23.7 mm. *Psammophyletria delicatus* is perhaps the smallest catfish in Africa. The largest specimen is only 20.5 mm. Although only two specimens are known, this probably is close to its maximum size. *Tetracauphilius augustifrons* is known up to 39.4 mm. *Tetracauphilius claudestiinus*, at only 19.2 mm, is possibly the smallest of all known African catfishes. Finally, we have *Zaireichthys maudevillei*, of which the largest known specimen is only 26.7 mm. Despite the fact that these species are all small, and that several of them are among the smallest of all of the African freshwater fish species, they are known only from the mainstreams of two of the largest rivers in Africa, the Congo and its largest tributary, the Ubangui.

These species live only in what may be described as great aquatic deserts, the outstanding feature of which is sand. These sandy deserts or plains often appear to be featureless. Seemingly uniform sandy stretches inhabited by Leptoglaninae are often very extensive, but individual fish are not uniformly scattered over wide areas. Just as in the great African deserts, the sandy terrain has some features frequented by more organisms than others. In the Ubangui River, where the greatest diversity of Leptoglaninae has been found, they are most abundant in (1) sand riffles, where water flows in streams from vast shallow areas into deeper water; (2) edges of sand bars, where vast featureless sand flats suddenly slope into deeper water; and (3) edges of hollows in the sand caused by large rocks. An effective way to collect leptoglanins is to search for any kind of unusual feature in the sand, then push a fine-meshed push-net deeply into it. The little fish often come out on top of the sand when the net is removed from the water, or it may be necessary to let the sand filter out through the mesh of the push-net. This is particularly effective for collecting small species and small specimens of the larger species, but apparently is not so effective for catching the larger species such as *Leptoglanis xenognathus*, presumably because they are too mobile. These may be caught occasionally by seining at night. Fishing with a push-net in large uniform sandy areas (sand flats) produces almost no specimens of Leptoglaninae, even if there is a good current. Leptoglanins only occur in habitats with flowing water.

The aquatic insect larvae, crustaceans, and other small animals fed upon by leptoglanins probably are most abundant in the special niches in the aquatic sand desert occupied by the leptoglanins. Leptoglanins are perhaps the only fishes in the Congo basin that can successfully exploit this special food resource. Total or near total exemption from predation by fish may be another benefit conveyed by their small size and habitat. Their sand-diving behavior, mentioned above, may be related to their feeding as well as to predator avoidance. Also possibly involved in detecting potential food organisms and predators is the sense of olfaction. Leptoglanins have large olfactory organs.

While living in large rivers and having small body size have some obvious advantages, there

probably are some disadvantages. How do they adjust to the marked habitat changes during the annual cycle of low and high water periods? How do such tiny fish locate each other when it is time to mate? During high water periods characterized by swift current and massive changes in the sand banks, the leptoglanins presumably are widely dispersed. How do they manage to come together again? During periods of low water they are found mainly in special places in the sand deserts, such as riffles, sand-bar ridges or fall-offs, and troughs or holes created by isolated logs or rocks. Individuals finding such a place are likely to encounter conspecifics if they remain there. As mentioned above, at least some leptoglanins have fairly large olfactory organs. These might function in intraspecific communication as well as in finding food and avoiding predators. Probably all leptoglanins produce copious amounts of mucus. This mucus, secreted by the pectoral axillary gland, might include pheromones or might itself act as a pheromone.

Sand-dwelling catfishes with a lifestyle and sand-diving behavior comparable to that of Leptoglaninae apparently do not exist in the rivers of tropical Asia. I have searched for them without success, especially in the mainstream of the Mekong and in its larger tributaries, but also in other large Asian rivers. The only ecological equivalents among catfishes appear to be some of the very small tropical South American Trichomycteridae and Pimelodontidae.

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**FIGURES 1-20**



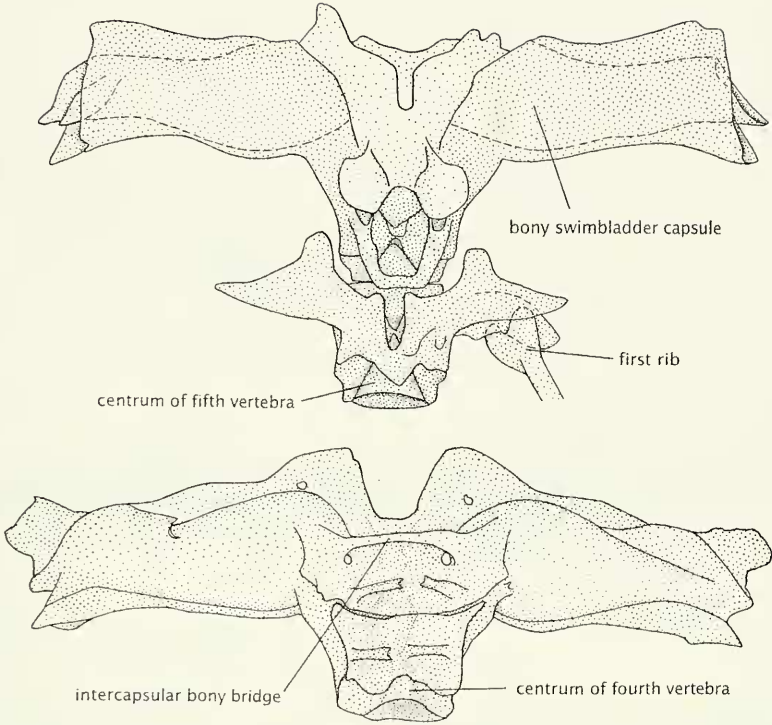


FIGURE 1. *Leptoglanis xenoganthus*, 41.4 mm, Stanley Pool. Dorsal and ventral views of the bony swim bladder capsules. The intercapsular bridge is a shared specialization or synapomorphy apparently common to all leptoglaninins and to the doumein amphiliid genus *Andersonia*.

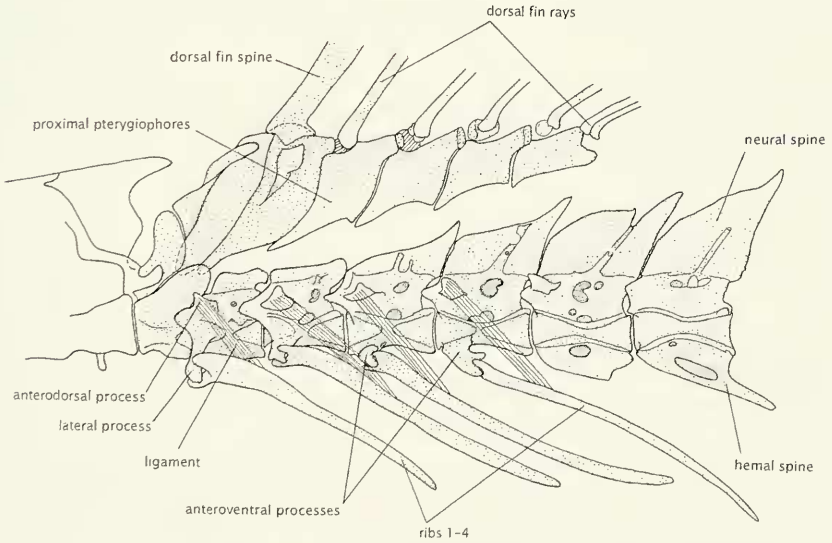


FIGURE 2. *Leptoglanis xenognathus*, 54.5 mm, Stanley Pool. Anterior portion of vertebral column and associated structures. Note specialized bicapital and ligamental attachment of ribs.

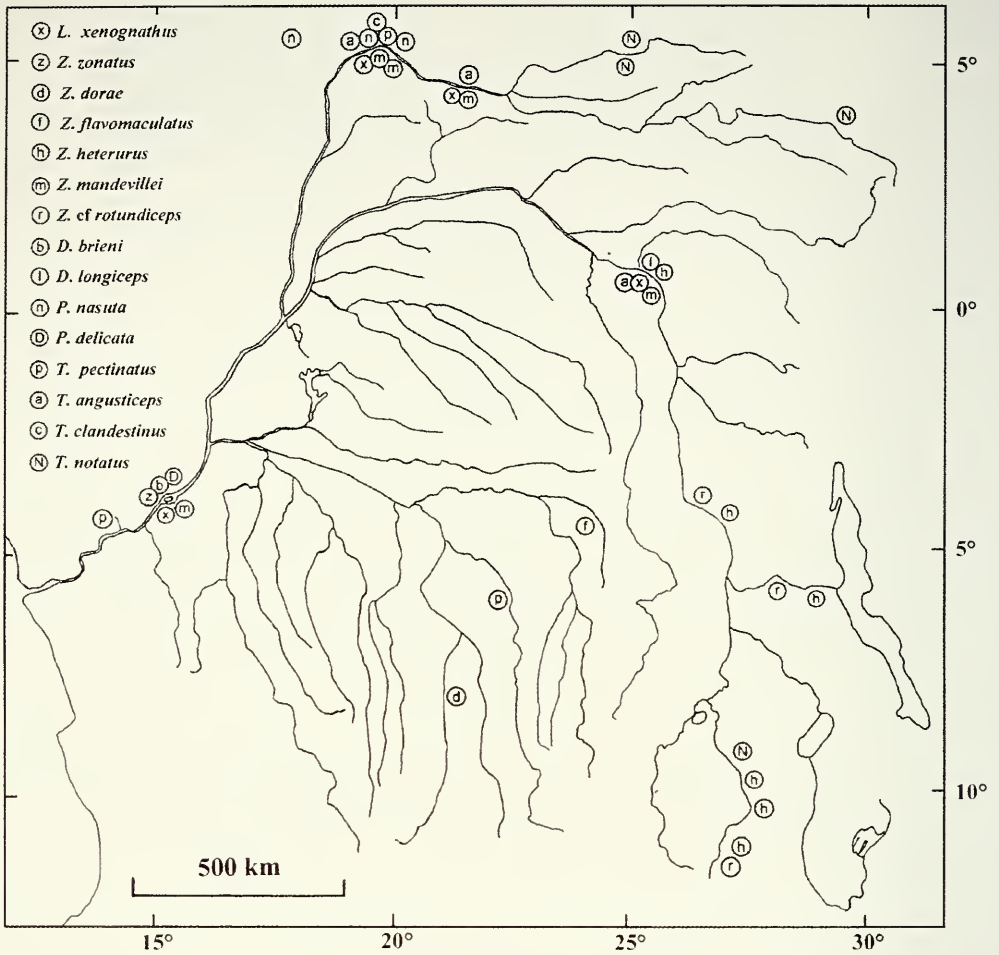


FIGURE 3. Distribution of Leptoglaninae in the Congo basin. Note clustering of species records on the Congo mainstream near Kinshasa (formerly Leopoldville), on the upper Congo mainstream or Lualaba at Kisangani (formerly Stanleyville), and especially in the Ubangui River upstream from Bangui. This reflects collecting activity as well as presence of favorable habitat.

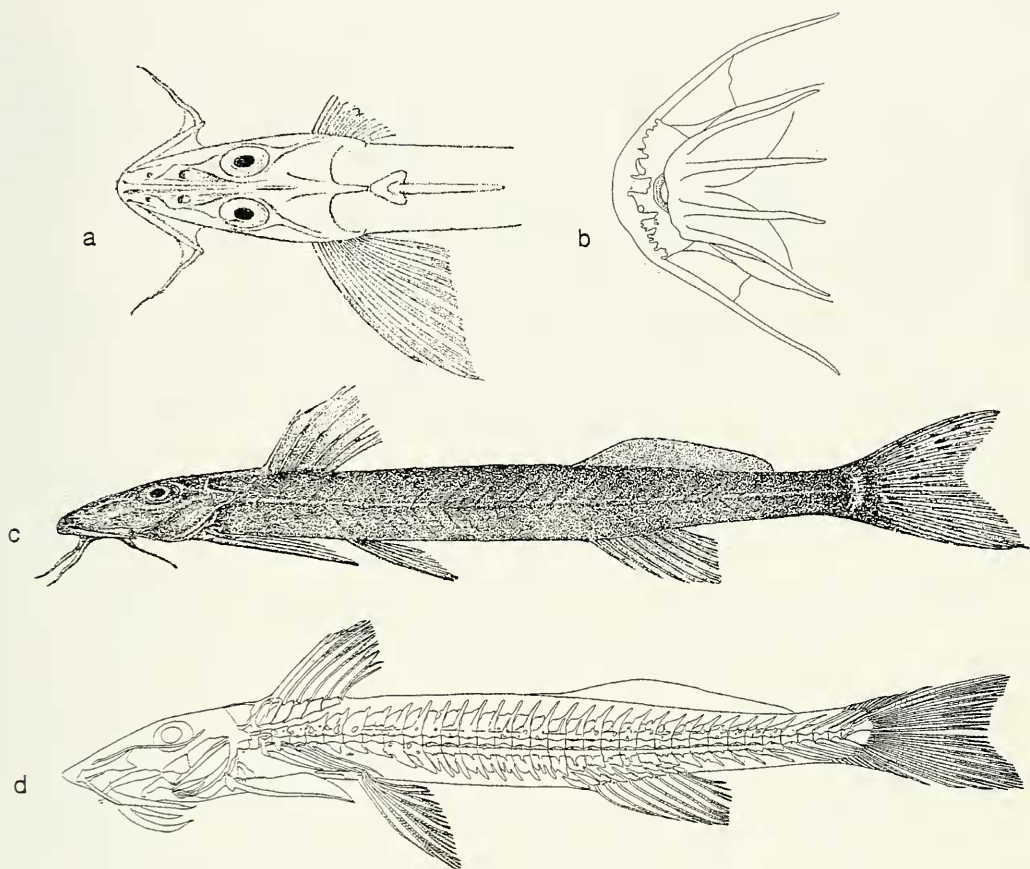


FIGURE 4. *Leptoglanis xenognathus*: a and c, holotype, total length 55 mm, Ubangui, dorsal view of head and full lateral view; b, 62.2 mm, Stanley Pool, ventral view of head; d, 53.4 mm, Stanley Pool, axial skeleton (vertebrae 21+18=39) (a and c from Boulenger 1911, Fig. 272).

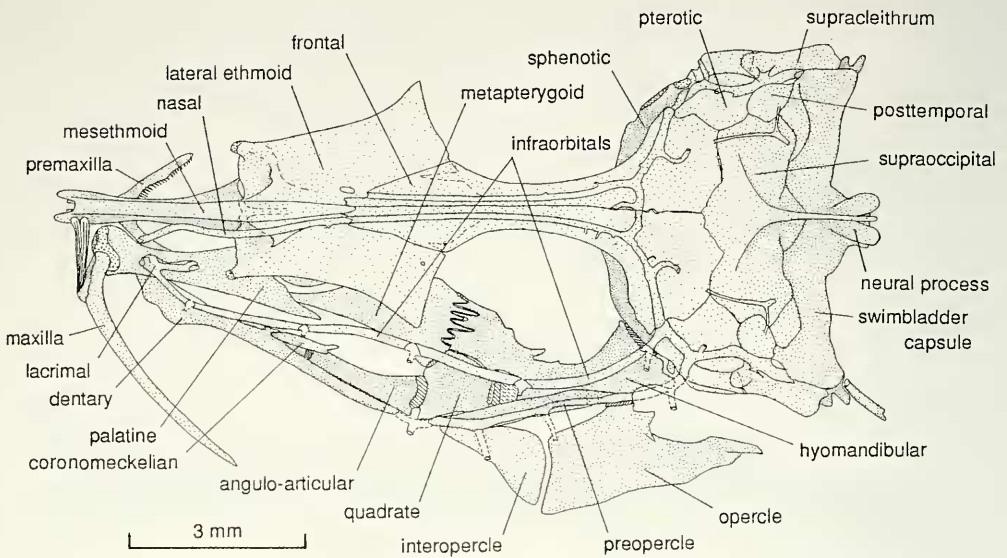


FIGURE 5. *Leptoglanis xenognathus*, 53.4 mm, Stanley Pool. Cranium, suspensorium and jaws (dorsal view).

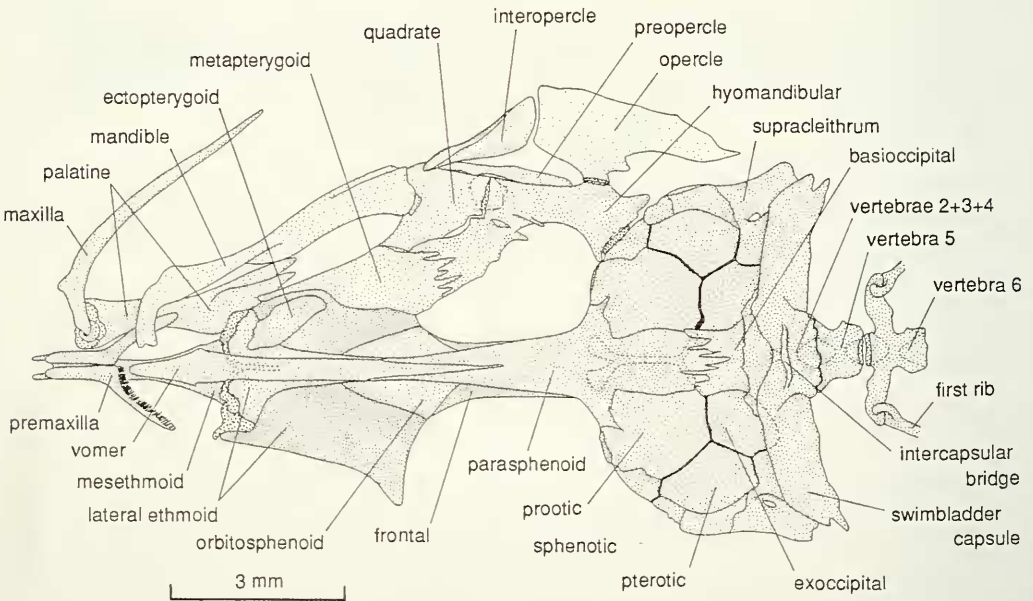


FIGURE 6. *Leptoglanis xenognathus*, 53.4 mm, Stanley Pool. Cranium, suspensorium and jaws (ventral view).



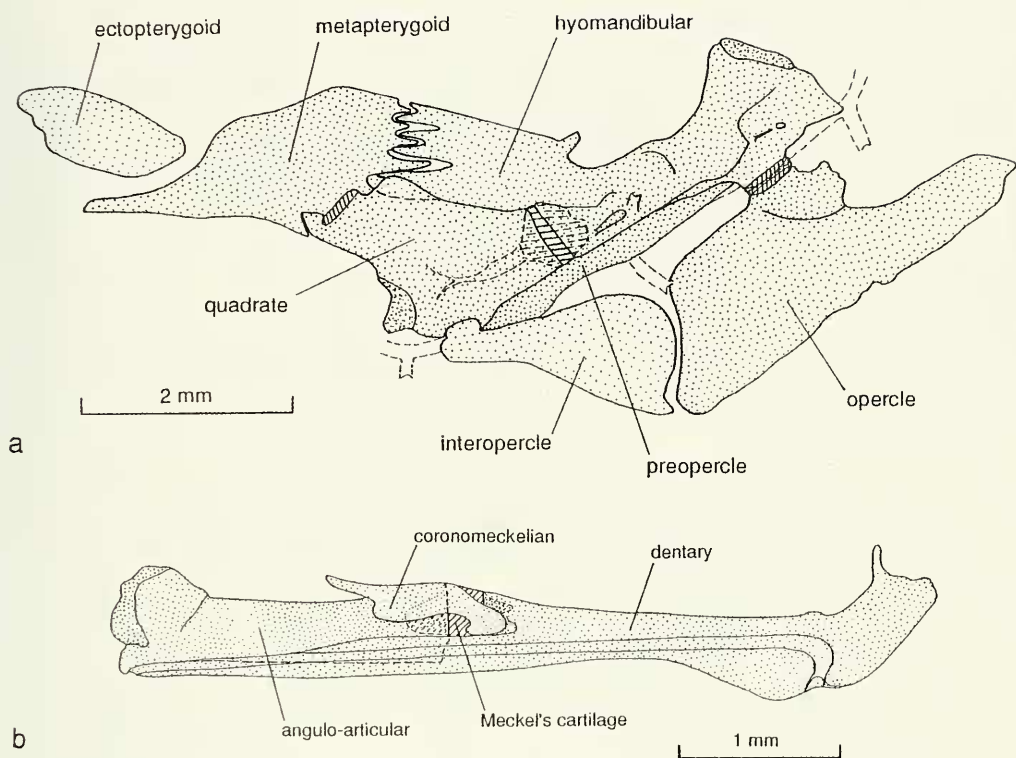


FIGURE 7. *Leptoglanis xenognathus*, 53.4 mm, Stanley Pool. a, suspensorium and jaws (medial view); b, lower jaw (lateral view).

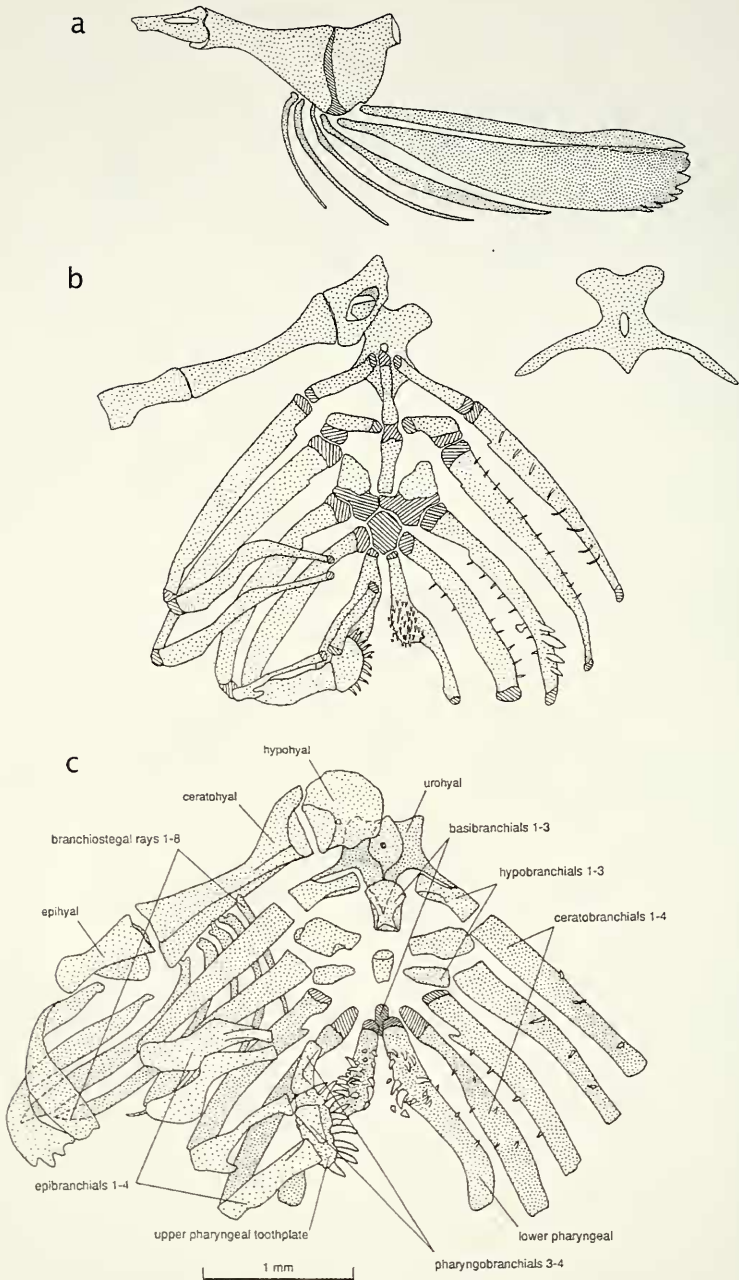


FIGURE 8. Leptoglaninae, hyoid and gill arches. a-b, *Leptoglanis xenognathus*, 54.5 mm, Stanley Pool; c, *Zaireichthys zonatus*, 18.1 mm, Kinsuka.

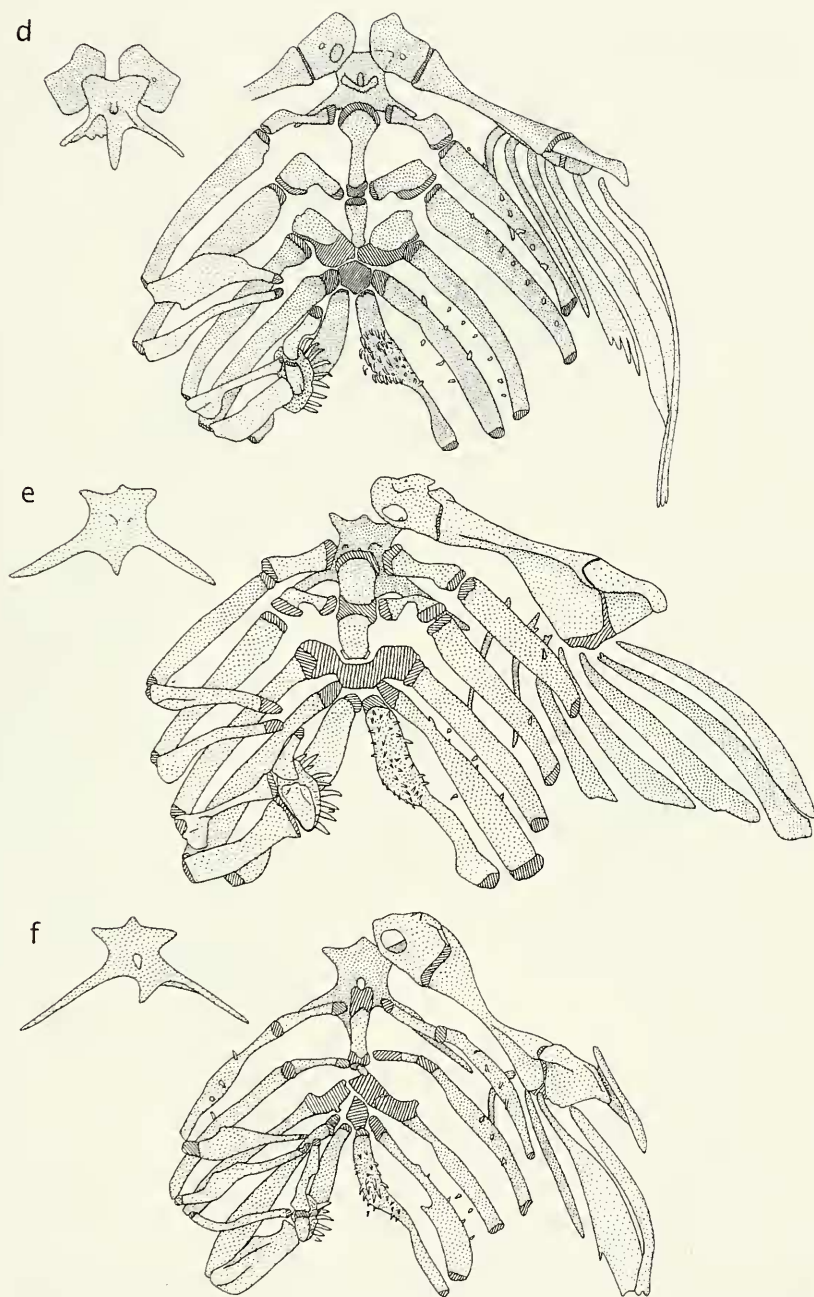


FIGURE 8 (cont.). d, *Zaireichthys camerunensis*, 30.0 mm, rivière Dele; e, *Zaireichthys mandevillei*, 22.3 mm, Banda; f, *Psammphyletria nasuta*.

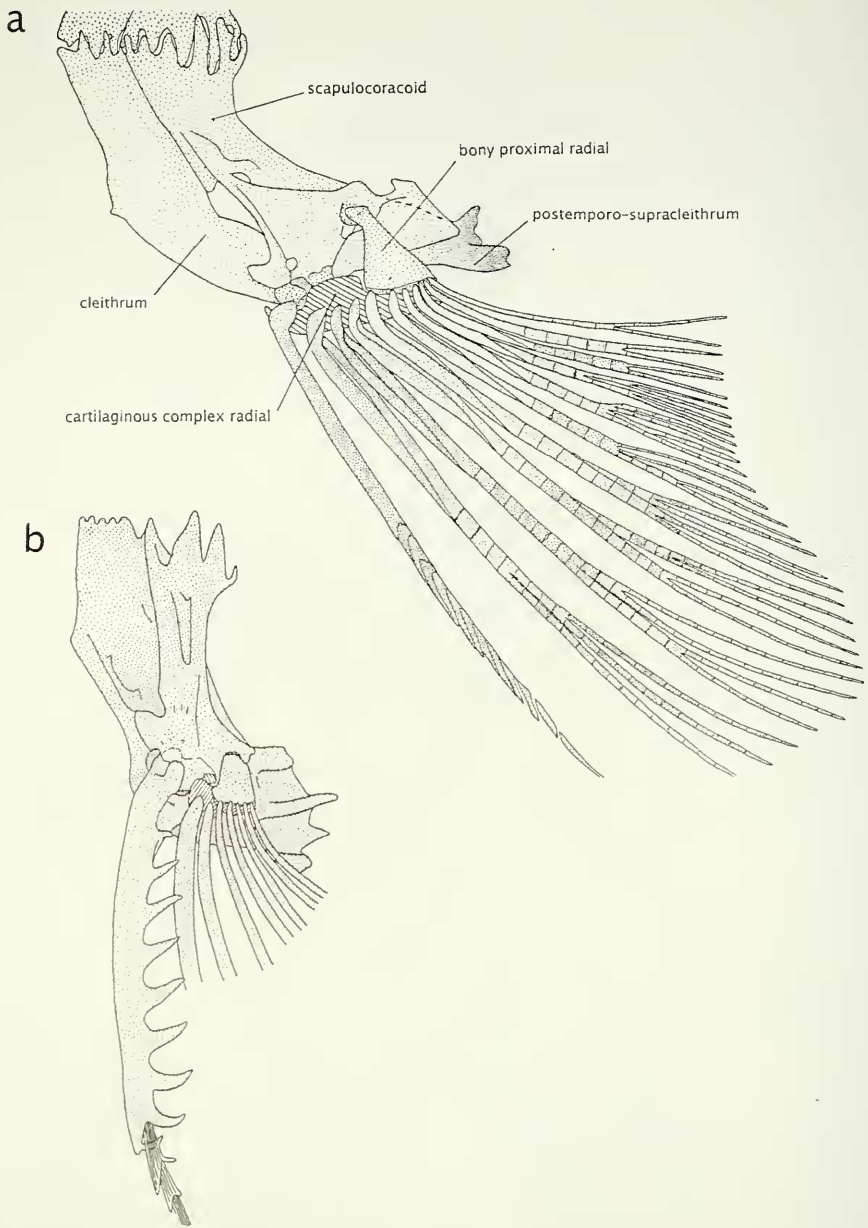


FIGURE 9. Leptoglaninae, paired fins and their girdles. a, *Leptoglanis xenognathus*; pectoral girdle and fin, 54.9 mm, Stanley Pool; b, *Zaireichthys zonatus*, pectoral girdle and fin (pectoral fin spine locked in erect position), 18.1 mm, Kinsuka.

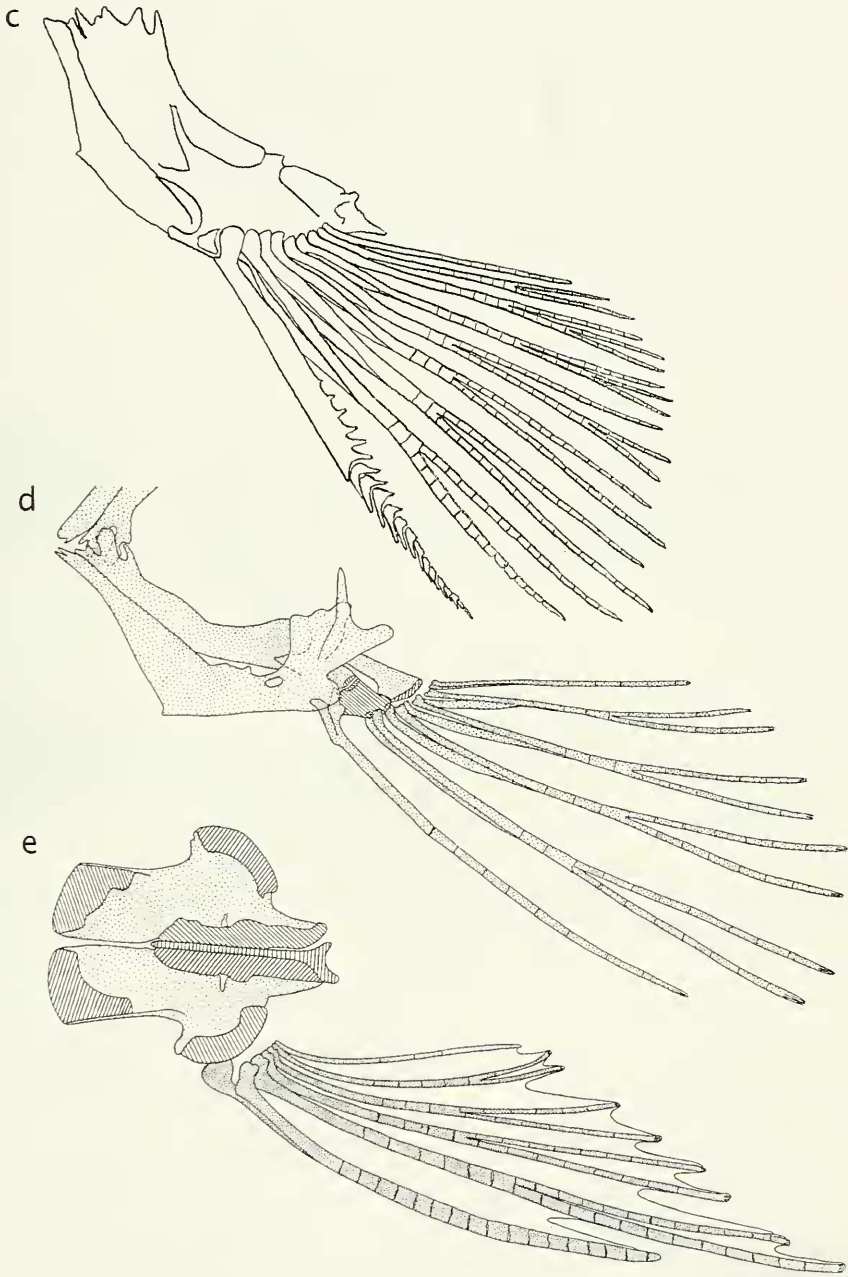


FIGURE 9 (cont.). c, *Tetracamphilus pectinatus*, pectoral girdle and fin, Luala watershed; d, *Psammophyletria nasuta*, pectoral girdle and fin, 23.2 mm, Banda; e, *Dolicamphilus brevis*, pelvic girdle and fin, 31.2 mm, Stanley Pool.

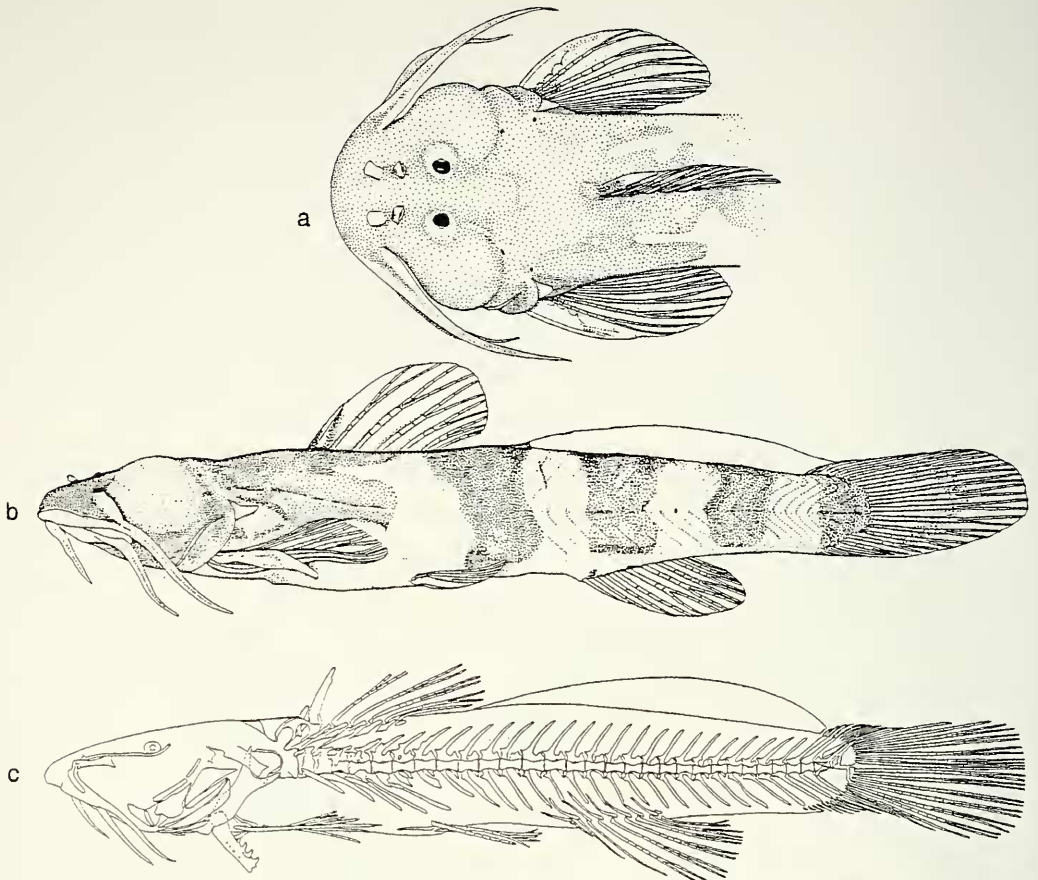


FIGURE 10. *Zaireichthys zonatus*, rapids below Stanley Pool. a, dorsal view of head (24.5 mm holotype); b, lateral view of body (24.5 mm holotype); c, lateral view of axial skeleton (18.1 mm paratype) (vertebrae 16+18=34).

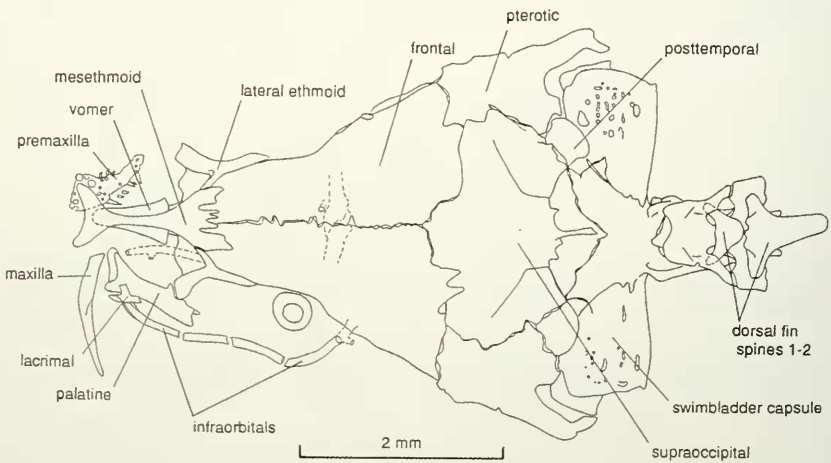


FIGURE 11. *Zaireichthys zonatus*, 18.1 mm, rapids below Stanley Pool. Dorsal view of cranium (with upper jaw).

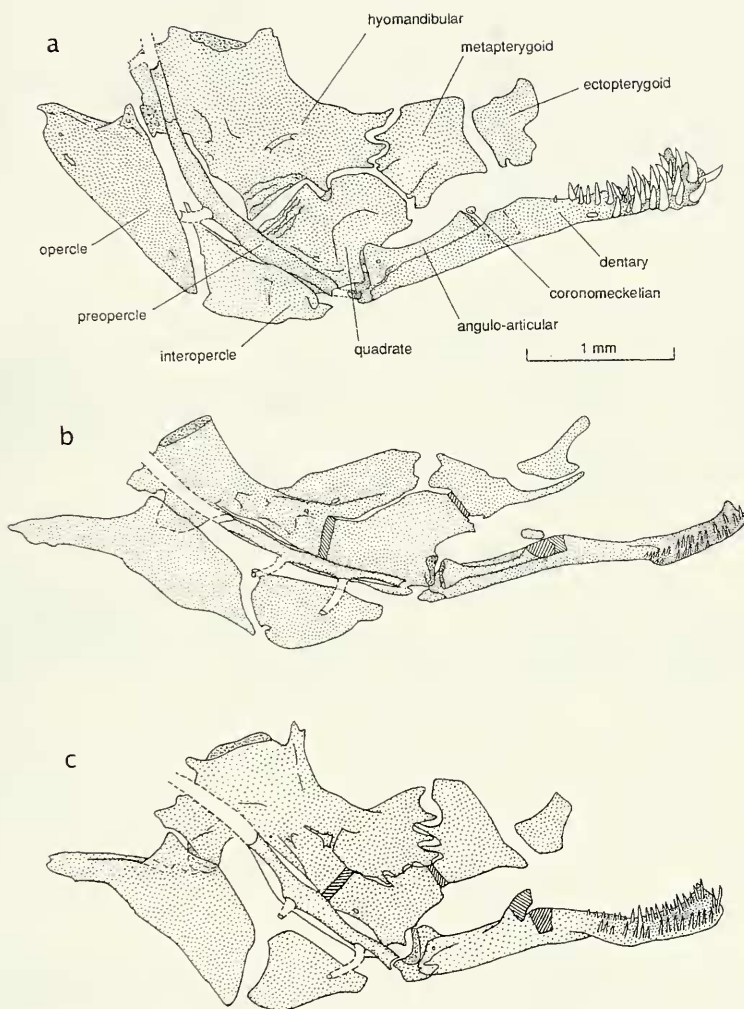


FIGURE 12. *Zaireichthys*. Suspensorium and lower jaw. a. *Z. zonatus*, 18.1 mm paratype, rapids below Stanley Pool; b. *Z. camerunensis*, 30.0 mm, rivière Dele; c. *Z. mandevillei*, 22.3 mm. Banda.

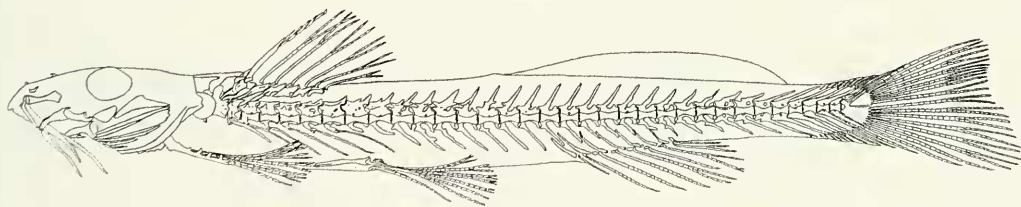


FIGURE 13. *Zaireichthys camerunensis*, 24.1 mm, rivière Dele. Axial skeleton (vertebrae 20+18=38).

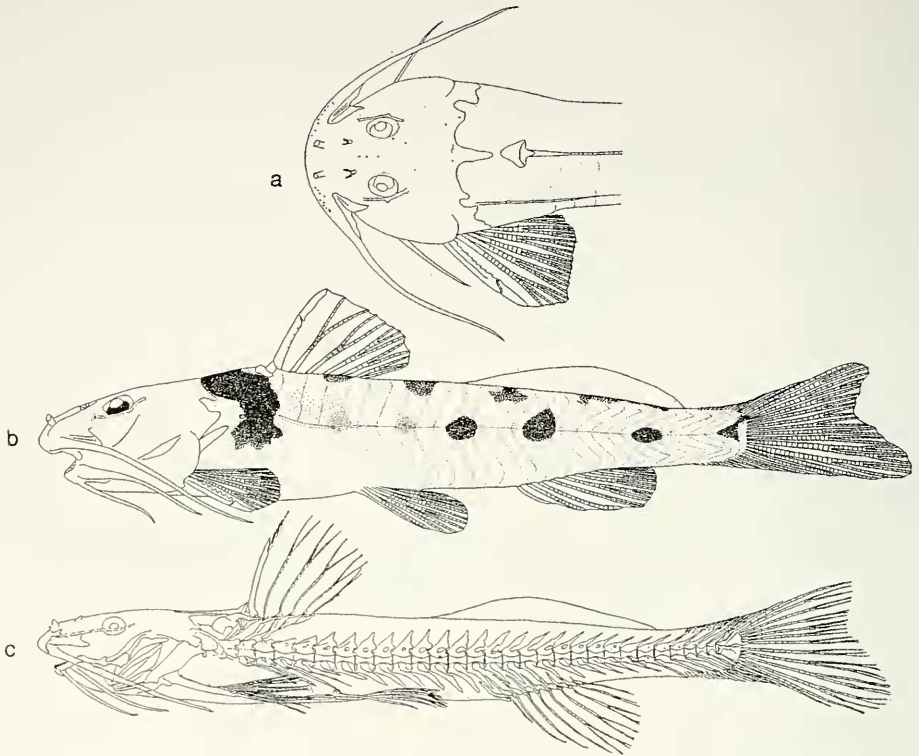


FIGURE 14. *Zaireichthys heterurus*. a, dorsal view of head, 31.4 mm holotype; b, lateral view, 31.4 mm holotype; c) lateral view of axial skeleton, 23.0 mm paratype (Lulindi) (vertebrae 16+17=33).

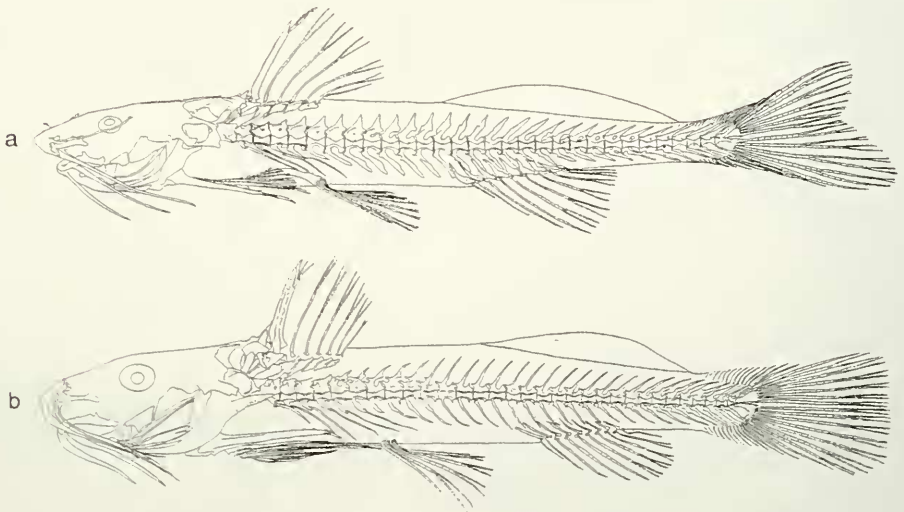


FIGURE 15. *Zaireichthys*, axial skeleton. a. *Z. mandevillei*, 21.5 mm, fleuve Ubangui near Banda (vertebrae 17+17=34); b. *Z. rotundiceps*, 24.1 mm, rivière Luwoyeye (vertebrae 18+17=35).



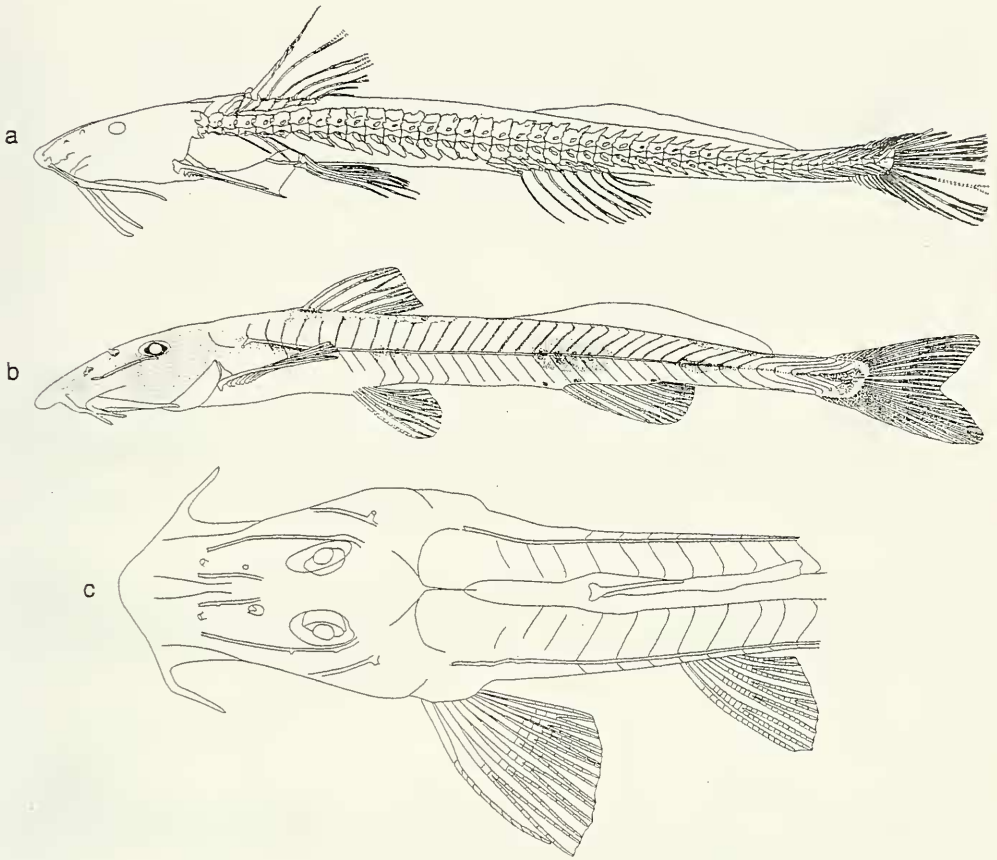


FIGURE 16. *Dolicamphilius*. a, *D. brieni*, 31.2 mm paratype, Stanley Pool, axial skeleton (vertebrae 18+24-43); b and c, *D. longiceps*, 42.2 mm holotype, Chutes Wagenia near Kisangani, lateral view; dorsal view of head and paired fins.

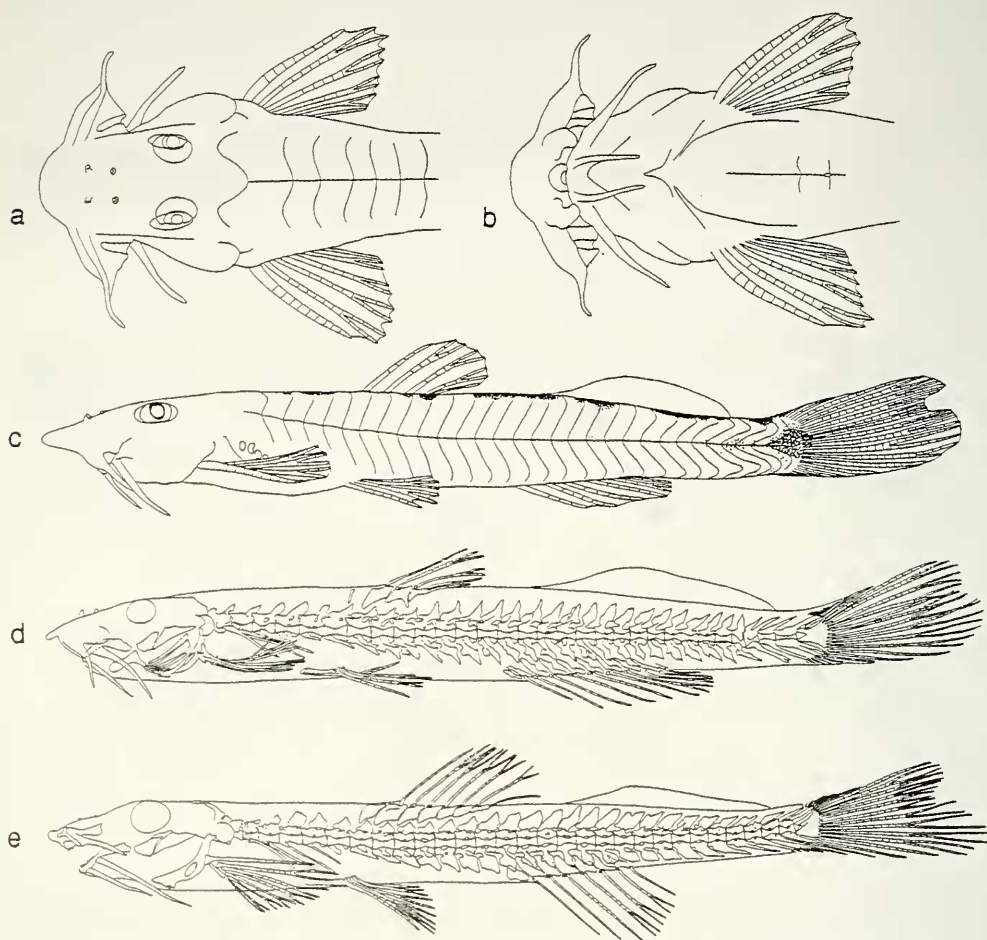


FIGURE 17. *Psammphyletria*. a-c, *P. nasuta*, 23.5 mm holotype, Ubangui, dorsal and ventral view of head, full lateral view; d, *P. nasuta*, 23.2 mm paratype, Ubangui, axial skeleton (vertebrae 18+18=36); e, *P. delicata*, 19.5 mm paratype, Stanley Pool, axial skeleton (vertebrae 17+16=33).

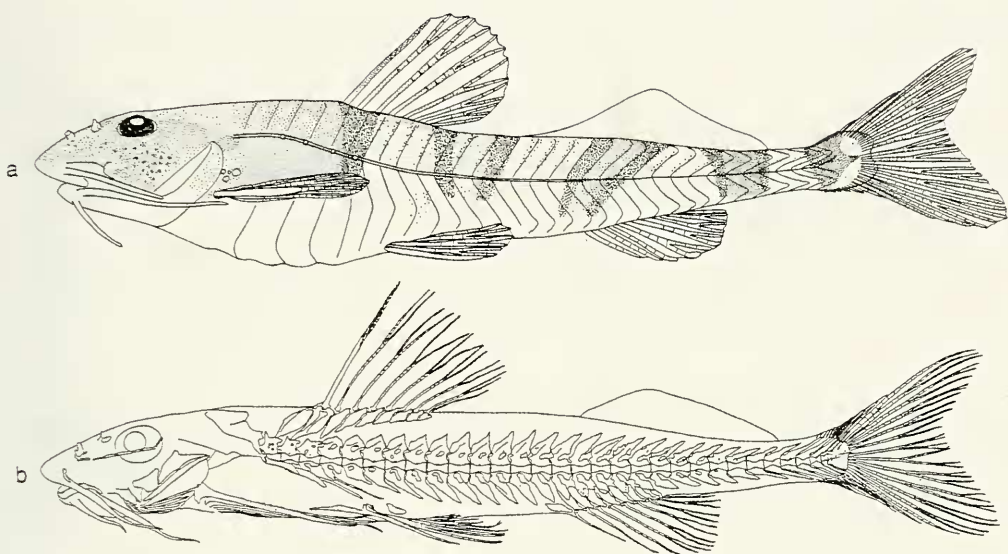


FIGURE 18. *Tetracamphilius pectinatus*. a, 33.7 mm gravid female holotype, Luala watershed, full lateral view; b, 28.3 mm paratype. Luala watershed, axial skeleton (vertebrae 18+18=36).

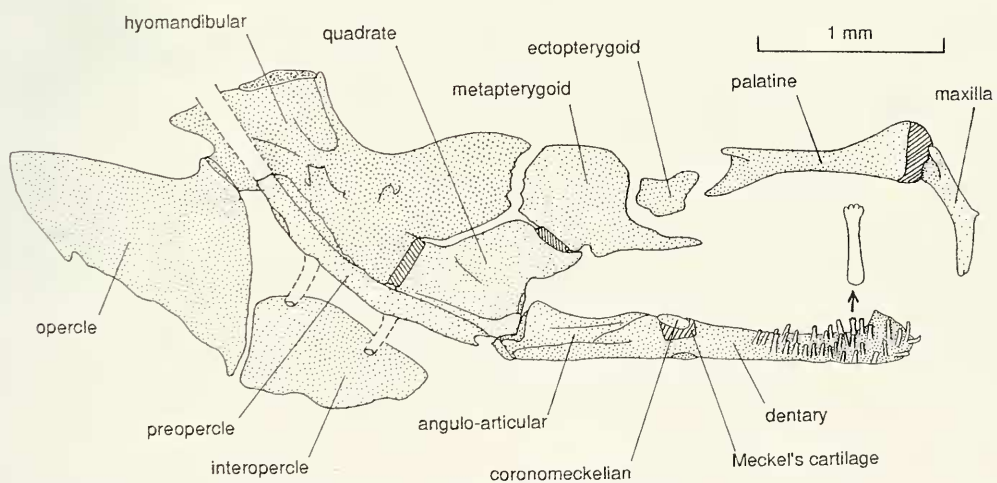


FIGURE 19. *Tetracamphilius angustifrons*, 22.3 mm, Ubungui, medial view of suspensorium and lower jaw.

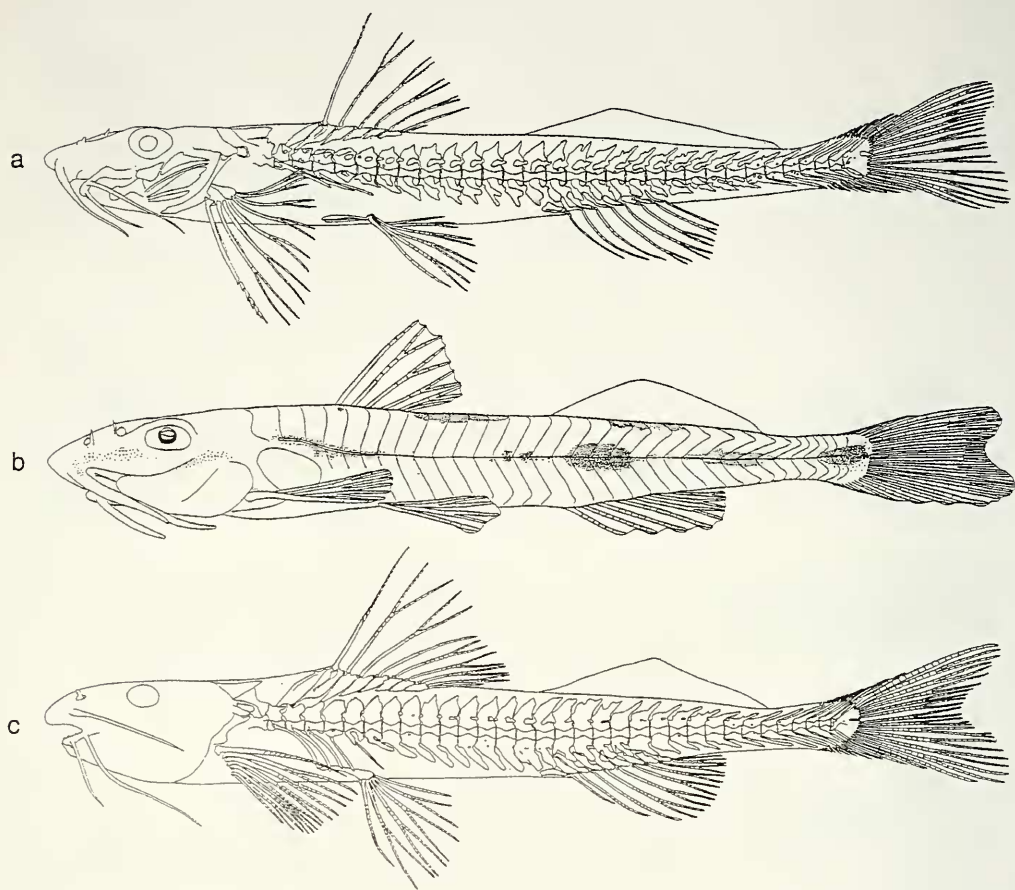


FIGURE 20. *Tetracamphilius*. a. *T. angustifrons*, 19.1 mm, Ubangui, axial skeleton (vertebrae 18+17=35); b. *T. clandestinus*, 17.8 mm holotype, Ubangui, full lateral view; c. *T. notatus*, 25.9 mm, rivière Chinko, axial skeleton (vertebrae 19+18=37).